Picturing Planning Perspectives

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Picturing Planning Perspectives:

Understanding Implementation of Geographical Information Systems for Land Use Planning and Regulation in the Costa Rican State

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Picturing Planning Perspectives: Understanding Implementation of Geographical Information Systems for Land Use Planning and Regulation in the Costa Rican State

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Acknowledgements

Writing a thesis is like writing a symphony. In the process one doesn't know how it will sound in the end. These remarks from one of my supervisors certainly were true for this thesis. Its elaboration was a winding road, with *staccatos, andantes allegros* and *marches funebres*. What comes immediately to mind were initial difficulties demanding redesign of my entire research to the reality in the field and the departure of my key fieldwork supervisor to Indonesia. Adapting the research also gave new opportunities, however, especially when I was able to participate in the exiting process of negotiations around new geographical data infrastructures. In musical terms I had found a refrain for my symphony.

My stay in Costa Rica was a period in major and minor. There was great joy and inspiration but also moments of deep doubts. In life and research things do not always happen as one expects. Doing fieldwork in Costa Rica was difficult because it was hard to be far away from my father's cruel decay caused by a rare degenerative brain disease. The country, however, also proved to be a unique place when my parents visited me and enjoyed speechless sights of volcano eruptions and sunsets at beautiful beaches of the pacific coast. My father's frustrations of loosing speech and memory dwarfed my own struggles in getting this thesis written. Sad music stirs the deepest emotions but one can feel rest, consolation and clearness of mind after its final note has faded away.

Not only the country's beauty made my stay pleasurable. During my research I had many helpful encounters with people from the GIS world, in ministries and universities and I thank all of them for their cooperation and patience with my inquisitive presence. For my fieldwork in Costa Rica I was happy to have a hospitable institutional base in *the Interamerican Institute for Cooperation on Agriculture (IICA)*. I thank its staff and administrative personnel. Without their support this research would not have been possible. I would also like to thank David Kaimowitz for staying in touch after he moved to Indonesia, two weeks after our arrival in Costa Rica. Every comment he made was to the point and appreciated. The people from the *Mesa Nacional Campesina* and the *Frontera Agricola Project* were inspiring during our many discussions and their reflections led me to better understand Costa Rican reality. Martin Chaverri Roig and Gerhard Jung shared their ample experience combined with warm friendship. Annick Schmeddes helped me tie up some loose ends after I already had returned to the Netherlands.

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Back in Wageningen I started muddling trough 'the bag of musical notes' I brought home from Costa Rica. The institutional setting of TAO gave ample room for individual creativity and my supervisors supported me throughout the project to further develop my own ideas. In the later phases Kees Jansen and Flemming Nielsen helped me making difficult choices. I enjoyed working together with Joost Jongerden and Jacob van Etten, and thank them for stimulating discussions and new ideas. Supervising students together with Gerrit Epema, John Stuiver and Arnold Bregt of the Centre of Geo-information was very inspiring.

During the writing period I became one of the first persons at Wageningen University to use speech recognition software. This was neither out of choice nor curiosity. A minor surgical treatment on my back and ambitious work resumption at an ergonomically incorrect workstation triggered RSI. Learning to talk to a computer was often a funny experience, and anger often was translated into laughter when the computer interpreted my swearing as "vacuum". Even though it took two years to fully recover, I did it. I thank especially Marcel, my *Taiji*-teacher Dirk Jan, Erika, Gemma, as well as all my Wageningen friends who generously helped us paint and move. Also thanks to the '*de Zaaier gang*' with whom we discussed the art of doing a PhD and exchanged the latest on Wageningen academia. 'The old friends' I thank for unconditional support and keeping things in perspective. Hans van Engen did the impossible in designing a cover in the nick of time.

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1

Introduction

1.1 GIS implementation in developing countries

Since the early nineties the introduction of computer technology in map making and spatial information production has been presented as an enormous improvement for land use planning and regulation (Fresco, 1993; UNEP, 1992; Simonett, 1993; Hassan & Hutchingson, 1992). The advantages of these 'Geographical Information Systems' (GIS) were widely acknowledged during the United Nations Conference on Environment and Development (UNCED) in 1992, which explicitly proposed the stimulation of modern technology such as GIS and Remote Sensing in developing countries to help overcome environmental problems (Agenda 21; chapter 40). In general GIS-technology was expected to contribute to monitoring, modelling and analysing environmental problems in an interdisciplinary way, and in stimulating faster or real time data provision for decision-makers. The use of GIS technology would lead to better decisions and guide sustainable development (Beek, 1991; Simonett, 1993:1; Bouma & Beek, 1993; Fresco, 1993; Fresco et al., 1990).

GIS also became very popular in development practice The introduction of the technology in development projects and programs has 'boomed' (Christiansen, 1998). GIS was seen at least as a big improvement, and it was often presented as a 'revolution' in understanding geographical reality, and being 'the solution' to many earlier problems of land use planning (Simonett, 1993; Hall, 1993; GISDECO, 1998). The popularity of GIS projects in developing countries often was related to donor-funding by bigger multilateral organisations, but bi-lateral local projects increasingly were also using GIS, and in 'the corridors' mention was made that no serious project can leave out a GIS component[1] (Christiansen, 1998; Mooneyhan, 1998).

To date, the majority of GIS applications remain concentrated in the developed world. Only 10% of the total number of software licenses are found outside of North America and Europe (van Teeffelen & Kwant, 1998). Also within the developing world the picture is highly skewed, with China, India and Brazil working with their own satellite programmes (Taylor,

[1] GIS projects remain very popular in 2003. Beside the use of GIS in environmental projects, GIS is also expected to contribute to projects for decentralisation and good governance, through more efficient and transparent information provision (e.g., GISDECO, 2002).

1991b), while most countries in Africa have little GIS technology, and development of it is often limited[2] (van Teeffelen & Kwant, 1998). Of the licenses in Latin America the highest concentration is found in the richer countries of Chile, Brazil, Argentina, Mexico, Colombia and Venezuela (van Teeffelen & Kwant, 1998). This shows that even though GIS was pushed internationally in many development projects, its diffusion was relatively limited, while the level of technological development and use has to be evaluated on a country by country basis.

In those developing countries in which the 'explosion' of GIS projects took place GIS helped to put the environment on the agenda of planners and decision-makers. In practice, however, the impact of GIS has been questioned, in contrast with the 'hyperbole' about its potential blessings (Maguire et al., 1991:9) the evaluation of the first years of experience in developing countries has not been all that positive. Especially implementation of bigger 'institutional' GIS in state bureaucracies in developing countries has been faced with numerous problems and setbacks[3] causing a discussion on the usefulness and feasibility of GIS projects (Taylor, 1991a; Yapa, 1991; van Teeffelen et al., 1992; Gupta, 2002), and a demand for more attention to organisational aspects of GIS implementation (Fox, 1991; Christiansen, 1998). Databases filled with 'best option' land uses, which have been developed at great cost, remain unused in centres of excellence, while ‘worst option’ land use continues. There are enormous problems of linking the GIS technology with actual practices of planning and regulation. This demands a better understanding of implementation processes and problems. It may not be technology, but how the institution “thinks” (Douglas, 1986) that causes difficulties of application.

The study object of this thesis is the implementation process of 'institutional' GIS in these larger organisations. The goal is to contribute to better understanding of the GIS-implementation, with a view to recommendations for future projects. This thesis will not extensively describe the technical GIS building modules and databases, not will it give advice on how to organise and improve these technical aspects of GIS implementation. Instead, by using a 'social studies of technology' approach, it aims to understand the interaction of the technology with the 'soft' factors of organisation and institutional aspects, and how this interaction influences the implementation process[4]. Through a contextual study of

[2] There are exceptions like some large programs funded by international organisations like the East African Highland Initiative with large GIS facilities in Kenya and GIS development in Uganda (Simonett, 1993).

[3] Also the experience in the developed world has been fraught with very similar difficulties (Ravi, 1993). Often the implementation takes long to become operational (five to ten years) (Christiansen, 1998), and e.g., GIS in Dutch government organisations is still a fairly new technology, in its starting phase (Grothe & Scholten, 1996). Evaluations are very general and qualitative and the expected revolutionary advantages are still more a promise of the future (Nedovic-Budic, 1998; Goodchild, 1998). Much of the literature on organisational and management aspects of GIS implementation below is based on experience in the developed world.

[4] The empirical material of this thesis is to a large extent based on formal interviews and informal conversations with people involved in the GIS community in Costa Rica. I held many extensive interviews with

implementation in three Costa Rican Ministries, the thesis illustrates the usefulness of the institutional approach. By looking at the implementation of GIS over a longer period, from 1990 until 1998, I will aim to assess the long-term influence and impact of several GIS-projects and look at how these projects relate to contextual and political developments. The research of the cases relates to the nineties, and no attempt is made to give an up-to-date description of Costa Rican GIS developments. The case material remains relevant and timely because of the continuing worldwide discussions on GIS implementation, calling for a better understanding of implementation processes (Nedovic-Budic, 1998; Campbell, 1999; GISDECO, 2002). Before sharpening the problem definition it is first essential to take a closer look at the technology itself: GIS for land use planning and regulation.

1.2 An overview of GIS: Definitions and Concepts

The term GIS in daily language refers to may different things. The interpretation varies from only the software, to a complete set-up with computers, the organisation of data delivery and trained and competent people (e.g., Longley, et al., 2001). If one asks for 'the GIS' of an office, technicians often will show a computer with colourful maps, they will explain the GIS-software, and perhaps print a map on a special large printer. Looking at the applications, GIS can be used for map-production, analysis and monitoring of geographical data in forestry, agriculture, hydrology, ecology and many other areas, in many countries and on many scales (Burrough, 1992; Longley, et al., 2001).

In many developing projects GIS is presented as 'revolutionising' map making and data management. The main reasons for its implementation and presentation as 'revolutionary' technology are the changes that GIS can bring to data management and map production. Compared to traditional map making several potential changes come to mind (Table 1.1). On a data-input level GIS makes it possible to use the large volumes of digital data e.g., produced by satellites. GIS also helps with the administration of databases, and makes it easy to update, add or change certain aspects (Burrough & McDonnell, 1998). While with a paper map, specific interpretation- knowledge about codes of representation was necessary, and often a separate book with additional data was made, in a GIS, databases and maps are stored together and linked. Also because it is easier to keep the original (disaggregated) data, it becomes possible to make more than one application of the data, and data can be used in a

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persons involved in GIS implementation of the three case studies. For reasons of anonymity, I will refer to this material in footnotes, with a code to identify the interview/conversation. Every code has a letter and a number. The letters (U, G, M, N, A) indicate the organisational origins of the person interviewed, while every individual interview received a number. (U) stands for University-personnel, (G) for Government (executive) official, (M) for Ministerial official, (C) for Consultant, (N) for NGO-member, (A) for a person from a parastatal and (P) for persons from the private sector. Throughout the period of nearly 2 years, I also studied two committees responsible for the implementation of GIS in the Ministry of Planning (TERRA) and the Ministry of Agriculture (IICA). I will refer to my extensive notes made during participant observation in these meetings by a footnote "meeting notes TERRA or IICA".

later stage for different purposes. GIS also makes it possible to do complex analysis that before was difficult, too time consuming or impossible (like e.g., summary statistics, geo-statistics, complex overlays or spatial modelling) (Goodchild & Longley, 1999). Presentations of results are easier to make and easier to change and exchange. Often the combination of computer presentations with colourful maps is mentioned as an important result of GIS. This would make data use more attractive for managers and policy makers.

Table 1.1 Arguments for computer cartography (from Burrough & McDonnell, 1998:7)

1.	To make existing maps more quickly
2.	To make existing maps more cheaply
3.	To make maps for specific user needs
4.	To make map production possible in situations where skilled staff are unavailable
5.	To allow for experimentation with different geographical representations of the same data
6.	To facilitate map making and updating when the data are already in digital form
7.	To facilitate analysis of data that demand interaction between statistical analyses and mapping
8.	To minimise the use of printed map as a data store and thereby to minimise the effects of classification and generalisation on the quality of the data
9.	To create maps that are difficult to make by hand, e.g., 3D maps or stereoscopic maps
10.	To create maps in which selection and generalisation procedures are explicitly defined and consistently executed
11.	Introduction of automation can lead to a review of the whole map-making process, which may also lead to savings and improvements.

In general speed and efficiency is mentioned as an important change that GIS could introduce in map making and data-production. In all the aspects above (data management, analysis and presentation) 'traditional ways of map making' would have been much slower. GIS is speeding up map making and enhancing potential applications of data enormously (Burrough & McDonnell, 1998; Goodchild, 1998; Obermeyer, 1999). We should consider, however, that especially in implementation phases training and adoption of the technology are often slow, and often data for more complex analysis are not available, and expensive to collect. Also many new products and applications that before were not produced would involve extra costs, while the final use of the information products often is uncertain. Therefore comparison between traditional ways of map making and GIS map making in terms of impact, cost and efficiency is difficult and should consider a wide ranging array of potential future applications and implications (see e.g., Christiansen, 1998; Nedovic-Budic, 1998; Goodchild, 1998).

As a complex general-purpose information system (Goodchild, 1998) with so many applications and application-fields it is difficult to find a commonly used definition for GIS. Each type of user will prefer a different definition (e.g., Table 1.2). The most widely cited definition of GIS is "...a powerful set of tools for collecting, storing, retrieval at will, transformation and displaying spatial data from the real world for a particular set of purposes" (Burrough & McDonnell, 1998:11). This definition emphasises the 'toolbox' aspects of GIS.

GIS enables map makers and information producers to do things better and faster than before. Others have emphasised the information system aspect of (G)IS. GIS is the information system with geographical data aspects (Aronoff, 1989). This definition helps focusing on the differences between general information systems and systems with a geographical aspect and points to the importance of the aspects of data related to location, relative position to other data objects, connectivity and containment. This approach is often used by technical GIS-builders[5].

Table 1.2 Definitions of a GIS, and the groups who find them useful (from Longley, et al., 2001:10).

A container of maps in digital form	The general public
A computerised tool for solving geographic problems	Decision makers, community groups, researchers
A mechanised inventory of geographically distributed features and facilities	Utility managers, transportation officials, resource managers
A tool for revealing what is otherwise invisible in geographic information	Scientists, investigators
A tool for performing operations on geographic data that are too tedious or expensive or inaccurate if performed by hand	Resource managers, planners, cartographers

Finally some authors choose an organisational definition, with GIS as comprising the computers with its total organisational context, personnel and finance (Carter, 1989). This definition emphasises the role of people and institutes in collecting, defining and using information. This definition was born out of the frustration with early institutional problems during implementation, and has the advantage that it points to complexity of the technology in its context. The definition is hard to operationalise because it makes all (institutional) aspects of technology implementation and use part of the technology itself. This makes it difficult to differentiate between technological aspects and human organisational aspects of implementation. Although I am interested in the organisational aspects of GIS, in this thesis I will use a 'tool-box' definition of GIS. This will help to distinguish the social processes around GIS implementation and construction from the technological aspects of GIS itself.

Using a more functional (toolbox) definition, Simonett (1993) schematically presents the use of GIS in 'Environmental Decision Making' (Figure 1.1). Although his 'environmental decision making' is maybe a little wider than our 'land use planning and regulation', I think the

[5] Burrough & McDonnell (1998) note that by the late nineties there was a growing differentiation between GIS builders and analysts, and more day-to-day users of easily to handle map material.

figure is very useful for understanding GIS. He uses the basic concepts of input and storage of data ('inventory'), that can be analysed ('analysis') producing the output in maps ('visualisation') or through more complex decision support systems ('DSS').

Simonett emphasises that GIS will especially contribute to decision making by functioning as a communication tool through the necessity of 'networking' to get information and to decide which information is relevant. This networking component involves sometimes new and/or different relations in information exchange and production, affecting organisational aspects of the information production landscape.

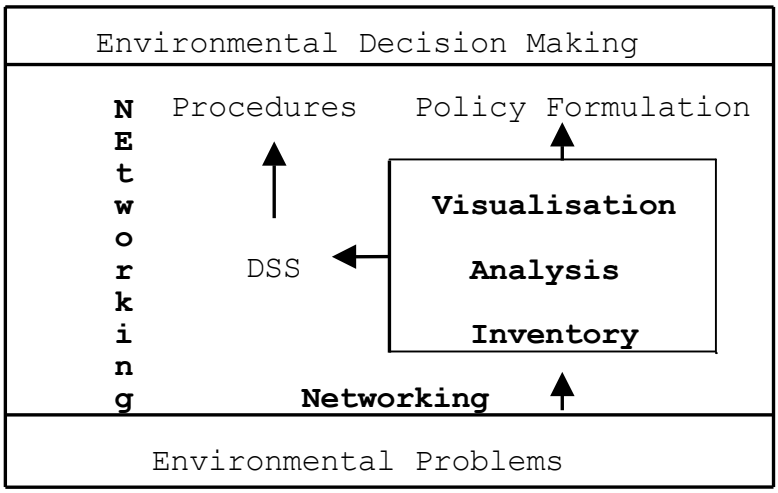


Figure 1.1 Model of GIS (after: Simonett, 1993:55)

Academics and practitioners often put much weight on the analytical possibilities of GIS (Nedovic-Budic, 1998; Fallas, 1995), and will say that using GIS for "only" map making is something inferior, sometimes even beyond their dignity[6]. It often proves difficult, however, to go beyond visualisation of general map-overlays and 'map-metaphors' (Goodchild, 1998:371). "GIS remains largely a technology of two-dimensional static deterministic data at a single level of resolution" (ibid.). It appears to be difficult to include time, the vertical dimension, uncertainty and hierarchies of generalisation. Discussions on these more sophisticated applications of GIS are confined to the research community (ibid.). In Costa Rica for example, GIS was mostly used for mapping and database management (Fallas, 1995). Simonett (1993) explains that these applications of visualisations of simple map overlays are very important for strategic decisions on land use planning and regulation ('policy making'). Although perhaps not too popular with GIS developers, because such

[6] The remarks of a Costa Rican GIS operator illustrate this : "... I am always offended if people come to my office, only to ask for some maps for some report they are working on.... This is why I am very pleased with your idea of finally using it [GIS] in an intelligent way... and for which it is meant to be used...[namely a land evaluation system with some analysis].... Here in this building they only want to have maps…" (IICA meeting notes, 12-08-97).

applications do not involve the latest technological features, these presentational functions are important in environmental decision making for consciousness raising or agenda setting (ibid.; Celis, 1997). In the same way, monitoring (administering and visualising land use change) with use of GIS and Remote Sensing is also seen as strategic for land use regulations and enforcement (UNCED, 1992).

Simonett thinks that often complex modelling in land use planning is overrated, and that it can be difficult or even dangerous because of error propagation or overall uncertainty about the final error of its outcomes (Simonett, 1993; Thompson & Warburton, 1985). Moreover, environmental decision making is often too complex to model, involving many actors and often no 'model' of reality is available for long term problems at hand (Driessen, 1989). Still, in some cases when problems are well defined and procedures exist to deal with a specific problem 'Decision Support Systems' (DDS) can be used to improve decision-making[7].

The discussion of GIS definitions shows the important components that should be taken into consideration when thinking about a GIS. It is clear that GIS is a complex composite technology with many applications, and GIS often causes new definitions of organisational tasks, and exchange of data, products and experience (Campbell, 1999; Simonett, 1993). In many projects GIS implementation is seen as a rather technical process, and the efforts are often limited to isolated projects to transfer computers, software and planning models (Campbell, 1999). Past experience shows that links with existing practices of land use planning were absent or at best just assumed. GIS and its planning models were often irrelevant or at best decision-makers did not perceive the utility at the moment (Dent, et al., 1994). The scheme of Simonett nicely shows that GIS and modelling are not only about understanding and controlling nature, but also about negotiating through networking processes concerning which information is considered important and relevant. GIS is also about convincing decision-makers to take action. GIS implementation is, therefore, a social process centred on translating user needs, convincing end users and (re)defining information and institutional tasks. It is just as much about creating 'platforms' to use environmental knowledge (Röling, 1994), as it is about, understanding nature and computers. It is also about the need for legitimacy of policies and power relations in planning practices (Campbell, 1999). During the process of implementation several conscious and unconscious 'social' choices are made about the technology. Choices comprise decisions about the types of abstractions of the reality represented in data bases, data scales, and ways to collect, use and distribute data. The GIS will also reflect choices of potential future uses of information for

[7] An example of this is the use of GIS modeling to calculate the loss of income because of reduction in crop growth due to waterpumping installations in the Netherlands (Bouma, 1993). This study was possible because the relations between crop growth and water limitations are well known. Crop growth relations with limitations of more than one nutrient is very difficult or impossible to model because of complex interactions and specific crop reactions (Driessen, 1989).

e.g. extension purposes, finding new areas for interesting investments in export crops, controlling a subsidy system or convincing policy makers and managers. All of this underlines the need to look at GIS as a social process as well as technique.

Because this thesis focuses on the implementation process of 'institutional' GIS in larger government organisations, as mentioned above, I will use a toolbox definition of GIS. This will enable me to keep clear the distinction between the technology from its social context, in order to focus on the interactions between technology and social variables. I will come back to definitions in the next chapter when I explain the theoretical background and methods of this thesis. Before we are in a position to pose precise research questions, it is necessary to underline the problem to which this thesis is a response. To explore that problem we need not to look further than 'my own backyard': the Wageningen University and Research Centre's Costa Rican Atlantic Zone Project that ran from 1986 to 1999. While this thesis is not explicitly about this project, it illustrates the frictions surrounding GIS implementation and use. Moreover, the problems this project faced also were one of the motivations for this research.

1.3 Illustrating the Problem: 'The Atlantic Zone Project' transfer or virtual reality?

In 1991, Wageningen University council voted with a one vote majority for the continuation of the Atlantic Zone Project in Costa Rica (later called 'REPOSA'[8]). The purpose of this project was to develop a toolbox of GIS and models for Land Use Planning, useful for the Costa Rican counterpart, the Ministry of Agriculture. Critical student groups in close contact with Costa Rican farmers had almost caused a halt to this multi-million dollar project. Their critique was that this 'tropical play-ground' for scientists did not take 'real Costa Rican problems' into account, was focused too much on easily transferable research in standard conditions (especially banana plantations), was too technocratic and too much focused on overall land evaluation and planning, leaving farmers' perspectives out of the picture (Hijfte et al., 1990; Blauuw et al., 1990).

Wageningen University later proudly presented its models and GIS as 'useful tools for planning and sustainable development' (*Wb-magazine, March 1999*). These tools had been 'transferred' to the GIS department of the Ministry of Agriculture in the last years of the project. The official position of the Wageningen University was not to interfere with how

[8] REPOSA (Research Program on Sustainability in Agriculture) also has also meaning as the Spanish word '*reposa*' from the verb '*reposar*' which means '*to rest*' or '*pause*'. In the light of the creative use of many other abbreviations of the project (e.g., USTED, one of the projects' core-models, means "for you", in Spanish), cynics might assume that the project intentionally wanted to suggest it could be viewed as a 'tropical holiday' for its researchers and students.

Costa Ricans put the Wageningen models to work: "How the Ministry will use and adapt the technical tools is responsibility of the Costa Ricans … they have to set their own priorities. We will not point with our finger, that would be [like] development aid of thirty years ago." (Bouma, quoted in:*WUB, 9-April 1998*). However, there was no use at all. The story of WAU project will show various aspects of implementation problems. It addresses the burning question as to what went wrong with the implementation of the GIS and models of the Wageningen project.

The Atlantic Zone project ran from 1986 to 1999, and was meant in practice for the training of students from Wageningen University in tropical specialisation's of land evaluation and land use planning (Hijfte et al., 1990). It had an annual budget of around 550,000 Euro (Jansen & Azofeifa, 1999). Officially the project was a cooperation with the Ministry of Agriculture, and the Tropical Agronomy Research and Higher Education Centre (CATIE), but in practice the Dutch largely stayed on their island of 'Little Holland in Guapiles', a small town in the Costa Rican Atlantic Zone (de Vos, 1996; *WB-magazine, april-1999*).

In the first years of the projects the expectations of the cooperation partners had already diverged. For the contact person at the Ministry of Agriculture it was already clear from the beginning that "they would just do what they wanted, and that the cooperation was only existing on paper"[9]. The university was producing soil maps and other information that would be available for the Ministry, and according this informant, that was all that could be expected by the Costa Ricans. He was right in his assessment because the goal explicitly mentioned that the project would only 'develop methods and models', while training and application would be up to the 'partners' (after the development of the models). In the eyes of the Wageningen people it was difficult to give training to the Ministry, 'because every four years, with the change in governments, half of the personnel was changed'[10]. Although it was true that some personnel left the counterpart department in the Ministry, the Wageningen project interpreted the Ministry's personnel policy somewhat incorrectly. The Wageningen project was functioning during a time of harsh structural adjustments which caused the outflow of people (Sojo, 1995). Wageningen University chose to avoid the uncertainties and difficulties within the Ministry by focusing on science and technology, postponing the 'transfer' to some future stage.

In this context, the Ministry also saw the Wageningen project more as a project that could generate some money and infrastructural benefits, while the personnel was conscious that the Wageningen project would not deal with the daily reality of the Ministry[11]. The different

[9] ex-government official (G42, June 1996).

[10] Comments by Wageningen researchers (U3, 13-12-1995; meeting notes of a visit to the project, 1-4-1996).

[11] ministerial officials (M51, November 1998).

expectations were not perceived by the Wageningen personnel or at least not seen as very important for the success of the project. Wageningen researchers did not expect that Costa Ricans would be involved in their project, while the Ministry of Agriculture at first mainly saw the project as a way to generate soil maps.

The attitude of the Wageningen University scientists was a reaction to experience from the earlier phases of the project. Although Wageningen started working on its own priorities, the student accusations of 1991, that the project did not work with farmers, were not completely justified. In the early years of the Wageningen projects, some researchers did establish contacts with farmers, but soon ran into trouble because of their misunderstanding of the importance of politics. At that moment the country was experiencing major farmer protests in reaction to the loss of government support for small and middle size peasants, during the structural adjustment programs of the eighties (Edelman, 1999). A group of farmers and the Land Reform Institute were present at a presentation of the first soil maps Wageningen produced. The presentation caused farmer protest because the Land Reform Institute 'had lied about the quality of land[12]' they had been given (Kroonenberg, quoted in Blaauw et al., 1990). Soil information, access to the information, definitions of 'soil quality' and GIS suddenly became a hot political issue. Wageningen refused to take a stance and pulled out of the conflict. The conflict disturbed the relations between Wageningen and the Land Reform Institute as well as with the farmers, who hereafter mistrusted the Wageningen project[13]. But also the Wageningen attitude changed after this incident. Although the Land Reform Institute was later often presented as a potential user of the models developed by Wageningen (Stoorvogel, 1995; Schipper, 1996), it was not involved in the development of models (Stoorvogel, 1995; 121), nor invited for training or to bigger presentations (Mera, 1998b; Brooijmans et al., 1998).[14] The experiments with 'ground-truthing' and participation in evaluating scientific research resulted in conflictive relations. Wageningen scientists had underestimated the extent that their 'science' would have political implications, and when they discovered this they chose to isolate themselves further, rather than adapt.

The new attitude of the Wageningen project was confirmed in discussions in 1991. The continuation of the project in 1991, after the tumultuous meeting of Wageningen University Council, represented a change in policy[15]. The research management team demanded that all

[12] international consultant and former researcher of the project (C10, January, 1996).

[13] international development worker (C20, 7-10-96).

[14] The institute was also lacking on the invitation list for a training course in 1996 (see also: de Vos, 1996).

[15]The students had organised open discussion workshops, to sharpen the critique, invite relevant decision makers, and present the results in the University Council. But also the responsible heads of Departments defended their case in favour of continuation of the project. I was present when they publicly threatened the University Council that all research activity in developing countries would be stopped if the project would not be approved.

researchers would focus their work on building 'one big interdisciplinary model for land use planning' and discontinue earlier research initiatives which would not fit 'the model'[16]. GIS was seen as important for structuring the database and making attractive presentations. Several land use scenarios were built to predict effects on land use if policies or prices were changed. According to one of the leading professors, the project was 'not a development project' and did not aim at practical implementation. "Science does not propose societal goals, but only presents how those goals can be reached, and what the consequences are from those choices" (Kroonenberg, quoted in de Jaeger, 1993). Politics was politics and science science. But instead of building models on policy practice, policy choices and information needs were assumed.

Changing the approach in this direction was not only a way to counter student protests, but to prevent the project from running into 'real' difficulties, and from getting too involved in complicating politics of cooperation with Costa Rican institutions. Following a more 'technological deterministic' view (Campbell, 1999) the GIS and models were now developed in isolation from their context and intended user groups. GIS- and model implementation in counterpart organisation would come *after* its total development, and would be a simple and straightforward technology transfer process.

This specifically technological deterministic approach to GIS implementation, taken by the Wageningen project, can be illustrated by the vision presented of existing GIS projects when I began my fieldwork in the country. When the research for my thesis received funding in 1995, it was perceived with mistrust by the Atlantic Zone project[17]. In a letter, the Wageningen project stated that my topic of "implementation and use of GIS in a real policy context" could be of use for "adequate development of policy scenarios for the Wageningen-model", but this "constitutes the only real link between [my] proposed research and [Wageningen] activities"[18]. According to the Wageningen project in Costa Rica, "hardly any use is made of GIS ... by government institutions ...for land use planning purposes...and even though lots of Natural Resource Management related activities are started up (at least on paper), very few of these ever reach the operational stage"[19]. Warned by their comments I was very surprised to find a virtual explosion in GIS projects in Costa Rica after 1990, growing from over 30 (!) in 1995 to over 43 GIS installations in 1997 (of which I knew the starting

[16] former research staff (U98, 9-08-98).

[17] Letter from Bouma, Chairman Working Group Costa Rica, to the researcher and supervisors of this thesis, no date, date of arrival 8-02-1995.

[18] Letter of Jansen, Coordinator of the Wageningen project to Bouma, Chairman Working Group Costa Rica, 30-01-1995. This letter commented on the research proposal for this thesis research.

[19] See preceding footnote.

date)[20]. The large majority (70%) of the GIS-projects dealt with environmental or agricultural topics, aiming mostly (80%) at influencing policy and decision making. How was it possible that the presentation the Wageningen project gave of the Costa Rican GIS-world was so different from what I found on the ground? Were all the GIS-projects 'useless' and without any effect, as claimed by the Wageningen project? Or were these projects actually functioning and was it the isolated position of the Wageningen-project that led to the perception of GIS as having little impact on planning[21]?

Explanations can be found in the perception of the Costa Rican GIS expertise and the definition of what a real GIS would constitute. Although the Wageningen scientists knew about many initiatives of Costa Rican institutions, and were aware of the difficulties these institutions had with GIS implementation, it would seem that they blamed the difficulties more on the expertise of the Costa Rican GIS personnel than on wider institutional problems. According to the Wageningen University project, the Costa Rican state institutes 'were not that far' (yet) to be able to make optimal use of GIS. "We gave the digital soil map already three times [to the Ministry], and every time they lost the data or could not access it anymore..."[22] The Wageningen personnel also felt that the linear programming modules were too complex for the Costa Ricans[23]. What was missing was technical expertise and training. This led to the belief that training and transfer of the Wageningen GIS and models could be easy and successful. But, moreover, the Wageningen project perceived a 'real GIS' and models for land use planning as something only scientists could build and that GIS should involve complex models and analysis. This attitude reflects the earlier remarks in the description of the technology above, that simple map making and overlays are not considered worthy activity for a 'real' GIS person. Also scientific practice forced the researcher to publish original material and stimulated the focus on complex modelling and GIS-use. The difference of GIS use in a policy context (often simple and attractive maps) from the newest scientific possibilities (analysis and complex models) is bigger than many Wageningen scientists had understood. GIS efforts in the Costa Rican policy context were, therefore, perceived as something of inferior quality. Wageningen argued that their GIS and models would give 'useful tools' that could be used directly in 'operational' policy processes. Given this vision of transfer as a 'technical and training process' trouble was in the making.

[20] The inventory of GIS initiatives in Costa Rica is described in chapter 3. Beside these GIS 43 GIS initiatives, later I found out the existence of at least 10 others of which I did not have specific data.

[21] Later in this thesis I will discuss the many GIS projects in more detail to understand the 'real' impact of GIS projects in Costa Rica.

[22] Wageningen researcher (U3, 4-12-1995).

[23] project staff (U97, 17-09-97).

Many Costa Rican state officials perceived the Wageningen 'transfer efforts' as an afterthought that came a little late and did not include the needs of the Ministry. Wageningen scientists, from their side, were blind to the influence of information systems on the internal functioning of the Ministry (de Vos, 1996; *Wb-Magazine, march 1999*). At that moment, the Ministry was in a process of re-organisation, which deeply affected the position of the Land Use Planning Department. This department was most involved in GIS development and application. Threatened with closure, the Departments' priorities were guaranteeing their responsibilities in planning, and not with learning 'just another model for land use planning'. Upon my initiative, the Wageningen project was invited for a discussion on the future of GIS-use in the Ministry at national and regional levels. The discussion was part of the ongoing institutional reforms, and different even over-ambitious applications and information uses were proposed. Expectations of the GIS by the managers and members of the discussion were sometimes unrealistic given the resources available. The discussions reflected, however, the redefinitions of the responsibilities of different departments of the Ministry, in which information collection, definition and storage was a strategic component. Frustrated with the ambiguity and messiness around the objectives of GIS use, the Wageningen participant concluded the meeting was a waste of time, and broke off contact with the Ministerial discussion group. In the eyes of this Wageningen-participant the Costa Ricans did not understand the science of GIS and he wanted to stay far from the wheeling and dealing of institutional reform. Instead of seeing the meeting as a chance to understand the real 'practice of planning' of the Ministry, the Wageningen scientist assumed that their technological tools were neutrally useful for any outcome of the institutional reshuffle.

The Wageningen project, therefore, went ahead with the 'transfer' of its own GIS model. The frustrations with implementation started with discussion over 'time' and 'tasks' to be executed by whom. Data did not exist, or at best were not available in digital form. Who was going to collect the necessary data? Who was going to work with the models? Also the scale at which the Wageningen model should be used was unclear; some thought that the model would be used by the Central Office of the Ministry for policy analysis, while others thought that it should be implemented at a regional level for the extension service (Mera, 1998a). The Ministry's personnel were frustrated by the amount of data the model needed, and did not find it practical for operational use in the Costa Rican context. Collection of data was perceived as too costly and time consuming. The data problems were aggravated by several factors. Firstly, the isolated position of the GIS Department in the Ministry caused mistrust between departments (Mera, 1998b). Secondly, the model focused too much on 'planning' which at that moment was a dirty word in ministerial circles (*Wb-magazine, march 1999*). In times of Structural Adjustment, the Ministry was deregulating land use planning and changing its focus to technological assistance, instead of steering overall policies of land use.

But even worse for the relevance of 13 years of research was the fact that, in addition to implementation problems, there was no confidence in the outcome of the model. The Ministry thought the scenarios were unrealistic (Mera, 1998b). Later, a project staff member admitted that the model could not deal with the complexities of planning (*WUB, 9 April 1998*). It could possibly be used at the field level, but even this application was still limited because it did not include direct farmers' interventions, such as variations in time of weeding[24]. In the end, the model could only be used for exploration of certain trends, but the expectations created were often higher (*WUB, 9 April 1998*; Brooijmans et al., 1998). Through the use of data and modern techniques the model created a (false) image of 'scientific-ness', while similar (or more transparent) outcomes could have been reached through simpler methods (Brooijmans et al., 1998).

The 'transfer' of the Wageningen project consisted finally of the training of some people, and the production of two reports of one case area (Jansen & Azofeifa, 1999; Hengstdijk, 1999; Saenz et al., 1999). The Ministry never used the Wageningen model. Although later presented as an example of participatory development of GIS models (Jansen & Azofeifa, 1999:2,14; *WUB, 9 April 1998*), the Wageningen project team admitted they first developed a methodology (or model), before transfer was started (Jansen & Azofeifa, 1999;15). The failure of the transfer of the model proved them wrong[25]. The problems with the implementation of the Wageningen model were caused by Wageningen isolation and disregard for institutional dynamics in the Ministry (de Vos, 1996). Implementation was more than a ‘technology transfer process’, and depended on understanding the "vagaries and power-relationships" that are part of introducing a complex information system in any complicated organisational setting (Campbell, 1999;628). Campbell warns that "[implementation] is a process which has to be nurtured and cajoled over many years, and perhaps decades: it cannot be imposed or controlled" (ibid.).

1.4 The Problem Statement and Research Questions

This research is not about the Wageningen Atlantic Zone project, nor about the friction between scientists and politicians. The story about the Wageningen project, however, signals important assumptions about technology transfer and implementation. Because studies on ‘institutional’ aspects of implementation are very rare, this thesis will take the interaction of GIS-technology and its social context during implementation as the object of study. As the

[24] project staff (U95, 4-12-95).

[25] The success of a management system for banana-plantations (BANMAN) that was developed in close cooperation with the National Banana Organisation and a big producer showed the advantage of 'real' participatory development (*WUB, 9 April 1998*). But it also suggested that the student critiques were justified, and that Wageningen was 'doing science', in standard conditions and for specific groups. The research also did not have problems to find funding for follow-up (Stoorvogel, 1998pc).

example above shows, understanding implementation problems from only the technological limitations of training and knowledge leaves out an important part of the equation, such as the socially constructed dynamics of implementation and "the vagaries and power-relationships" that go hand-in-hand with implementation. The investments in the Wageningen project resulted in a considerable number of scientific publications[26], but the model itself was never used in Costa Rican practice. It seems that a focus on scientific methods prevented the early recognition of 'institutional problems'. This prevented the model builders from dealing with real tasks at hand, understanding the implementation process as an interactive process, and transferring their own final product.

My research proposal started with the notion that at present many GIS projects and models are, just as in the Wageningen project, too much developed by physical scientists with a 'technological determinist' philosophy. Although practical experience has led some physical scientists to signal that land use planning is more than models and maps, and involves a process of "grabbing hand holds" (Dent, 1988), too often scientists follow their own research agendas, convinced that they are approaching problems in the right way (Dent et al., 1994). The problem is that such a technocratic means of looking at GIS and its implementation is fundamentally flawed because it fails to recognise that land use planning is not only a matter of controlling nature, but also of achieving change among the human actors involved (Röling, 1994; Redclift, 1992). Land users, land use planners, institutional arrangements and politics all are part and parcel of the complexities of land use planning and its regulating models and information. "GIS development and implementation has to be seen as part of the environment in which they will be located, only gaining meaning through interaction with individual members of staff within a particular cultural and organisational context" (Campbell, 1999:627). To understand implementation processes, this thesis will not focus on the technological aspects of GIS implementation, but start from the GIS (implementation) practice in the policy context. GIS building and implementation will be studied as a continuous process of institutional interaction and change.

The study will be built around three major research questions, as follows:
1) Through which processes is GIS constructed (what choices are made, what is the influence of the main actors, and what is the influence of their social, political and institutional environment)?
2) What is the influence of GIS-changes (if at all) on land use planning practices?
3) What are the consequences for rethinking GIS implementation?

[26]One problematic aspect of the publications itself is the self-referential nature. The publications mostly talk about the Model, and the Model Results, without being able to translate the results to reality in a straightforward way. See e.g., Stoorvogel et al. (1995) and other articles in the special issue of the Netherlands Journal of Agricultural Science, no. 43, 1995.

Chapter Outline

The research questions are addressed and answered in the following seven chapters (2-8). In chapter 2, I discuss several approaches that can be found in the literature on GIS implementation in the developing countries. From this discussion I develop a theoretical and methodological framework. The discussions point to the importance of the context of the planning discussions for GIS implementation in complex planning organisations.

Empirical material is introduced first in chapter 3. This start with the historical development of land use planning and regulation, as influenced by different people, projects and factors. Change in ideas about planning and perception of the environment, as discussed in the national and international fora are outlined. This description provides the reader with an overview of issues important in the wider context. The function of chapter 3 is to give the background for understanding GIS implementation as part of ongoing change in land use planning and regulation.

Chapter 4 presents the GIS-landscape of Costa Rica. A description of the development of GIS in different organisations and its main applications will help understand the changes GIS has caused in information in general. The general problems and opportunities of the many GIS projects are discussed to provide a basis for understanding the technological context for three case studies presented in chapter 5-7.

GIS implementation in three ministries in Costa Rica is described in detail. The GIS implementation process of the Ministry of Agriculture is discussed first, as this Ministry was the first to use formal planning methods for land use planning (Chapter 5). It was also one of the first organisations in Costa Rica to implement GIS. The forestry monitoring system implemented under responsibility of the Ministry of Environment and Energy comprises the second case (Chapter 6). This Ministry was created in 1986, and with many connections in international conservationist fora, was experimenting widely with participatory planning methods, NGO involvement in conservation and market mechanisms for regulating land use. Its GIS for forest monitoring was part of a creative new system for implementing the environmental service of carbon fixation, as proposed at the Kyoto conference in 1998. In the last case (Chapter 7) the process of the implementation of the National Geographical Information System under the responsibility of the Presidential Committee for Land Use Planning is described, as part of ongoing discussions on intersectoral coordination of land use planning and the environment. While presenting itself as a neutral GIS-project the land use planning committee aimed at deep reform of national land use regulation responsibilities.

The three case study chapters will be described by first giving a contextual discussion of the land use planning debates of the subsequent ministries, and the consequences that different visions of planning have on information needs. The second section of each case study chapter

will give a short outline of the organisational embedding of GIS, and presents a periodisation of the implementation process. This short section serves as a guide for the reader, to get an overview of the remainder of the case. The last section of each case-study chapter is divided in three. In the first part an overview of political and financial support is given. This is followed by an analysis of how technological, data and training aspects of the particular GIS contributes to GIS implementation. In the last part actual implementation will be described in the context of political and financial support, the technical aspects, as well as the institutional embedding of the GIS under consideration. This enables us to understand the institutional as well as technical aspects of GIS implementation for each case.

In a final chapter (Chapter 8), I discuss the main research findings through a comparison of the cases. After a discussion of the general changes that GIS introduced in information production, map making and its applications, I will analyse the reasons for these changes and indicate the impact of GIS on land use planning and regulation. I will end the chapter by discussing the possibilities to generalise the findings beyond the Costa Rican case, and will give recommendations for future GIS implementation.

2

Understanding GIS Implementation in the Third World: Theory and Methodology

Introduction

Given continuing problems of GIS implementation in Third World countries, there is a growing literature discussing these problems and formulating strategies for new generations of GIS projects. This chapter offers an overview of these discussions and closes with an argument about the need to improve on theories of GIS implementation through ‘the social studies of technology' approach. This sets the agenda for the rest of the thesis.

In reviewing the literature I have divided it into three approaches or 'schools of thought'. The chapter first considers a body of literature on 'GIS-transfer' to developing countries (2.1). Authors of this school of thought draw on earlier experiences and give a good overview of the problems encountered. However, the literature does not give us adequate understanding of why problems arise and how to understand the 'soft' and institutional aspects of GIS. I turn therefore to more general literature on GIS implementation, discussing experiences worldwide. The literature on 'organisational aspects' of GIS implementation will give us more insight into the structure of information management in organisations and its dynamic aspects (2.2). In the last part of the chapter (2.3), I discuss the literature on the 'social aspects of GIS' and their consequences for GIS implementation in developing countries.

Because of several limitations of these different approaches, I will enrich the discussion on GIS implementation with a discussion of social studies of technology (2.4). In this section I will expand on the earlier approaches and include a contextual and a content element to understand GIS implementation. The discussion of the literature will guide us in the final section of this chapter (2.5) where the methodological approach of the current study is formulated.

2.1 The 'GIS-Transfer' Approach

In the early nineties many evaluations of the first applications of GIS in the Third World were undertaken, mostly by people working in the field of GIS (Taylor, 1991b; van Teeffelen et al., 1992; Simonett, 1993; Hassan & Hutchingson, 1992). These authors normally adopt a 'factor approach', in which lists of 'inhibiting' and 'enabling' factors for GIS implementation (Table 2.1) are described (Sahay & Walsham, 1996). It is worthwhile to look at these lists to get a better grasp of implementation problems from practice.

Table 2.1 Inhibiting and Enabling Factors for GIS implementation (adapted from Sahay & Walsham, 1996)

Factors	Details of Issues
Inhibiting	
	Availability of data and technical problems with remote sensing Data. Outdated nature of data and problems of standardisation
	Shortage of trained manpower lack of awareness about GIS
	Dominance of Technocrats
	Decision making in hands of few and/or sectoral form of organisation
	Financial constraints
	Technical constraints
Enabling	
	Developing user participation and developing local expertise
	Giving users prior exposure to mapping programs
	Evolutionary approaches to implementation
	Policies that stimulate coordination
	Role of external agencies

The difficulties with implementation were often referred to as 'transfer of technology' problems (Taylor, 1991a; Yapa, 1991). The main idea is that technology developed in the West cannot simply be expected to be transferable to Third World countries. GIS technology is inhibited because it is too 'technology- and expertise intensive', too costly and too much dependent on external expertise. Finally it is suggested that the institutional culture of long-term planning often does not exist in Third World bureaucracies (Burrough, 1992; Sahay & Walsham, 1996).

Other examples of inhibiting factors are e.g., that the technical requirements for a functioning GIS are inadequately met, because of a more unpredictable environment,

including unstable electricity supply, dust storms or tropical moisture. The Costa Rican Tortuguero Conservation Area for example, constituted an ideal climate for a mould growing on the hard disk that caused the loss of all data[27]. Technically these problems could be overcome, although the costs might sometimes be too high. In Costa Rica, the conditions are relatively favourable because of a well-developed electricity, telephone and road system, and a general high level of development.

Data availability, updating and exchange were often more problematic than in the West. As a more structural problem this could require, in addition to investment, changes in institutional ways of data collecting and cooperation. Finally, long-term aspects of operation costs and training were often not taken into account in GIS projects. In Costa Rica there was a lack of trained people, and people with appropriate training were difficult to keep because the attraction to work as consultants in other projects or in the private sector (Fallas, 1995; Diaz, 1997b).

Realising these difficulties, many GIS-practitioners became sceptical about the enormous popularity of GIS technology in donor circles, and criticised the push by software companies advertising GIS as a solution for all development problems (Hall, 1993; Christiansen, 1998). Still, although critical of past experience, the overall argument of this body of literature is that it is not so much the technology as the way it is implemented that is the problem (Christiansen, 1998). In a footnote Christiansen suggests that the authors of this body of literature would never totally reject GIS-technology because 'GIS-implementation of course also was their job' (ibid.:43).

Many authors agree that it would be better to follow a stepwise implementation. Often referring to participatory methods (in their eyes this is taken to mean working with national experts), they advise that more success would be attained through 'indigenous development' (starting from the organisational tasks at hand) (Taylor, 1991b; Hall, 1993; Simonett, 1993)[28]. Also the generalisations around GIS-transfer were criticised, calling for a more case by case approach to implementation, because there is not 'one Third World', nor one GIS (Christiansen, 1998). To help discuss the variety of GIS projects, a common and useful distinction became popular in the literature. GIS applications were divided in 'project or departmental GIS' and 'corporate or institutional GIS'. The former type of GIS applications aims at the specific tasks of a project and has limited users, while the latter concerns GIS applications based on sharing data sets for more or less complicated uses in a complex organisation (Christiansen, 1998; Clark, 1998).

[27] GIS operator (NGO16, 5-12-97)

[28] For similar arguments for Land Evaluation see Fox (1987) and Wambeke (1987).

After the technological developments of the early nineties, such as the enormous increase of calculation speed, and better software, together with cheaper computers, GIS implementation became technically less problematic. Many 'inhibiting factors' became less relevant, although many (institutional and data-related problems) remained as before. This explains why the literature evaluating projects from later periods is more positive, especially in the case of 'project GIS'-applications (GISDECO, 1998; GISDECO, 2000; Christiansen, 1998).

The popularity of bigger, nation-wide applications (often corporate or institutional GIS) declined somewhat during the second half of the nineties. This was sometimes explained by reference to the frustrations, with early larger GIS projects, of practitioners who learned their lesson well (Christiansen, 1998). World Bank and UN projects especially came under attack for their stimulation of bigger national or international GIS centres. The critics thought that these were the new '*white elephants*', implemented without coordination, with outdated or useless data, and lacking clear goals (ibid.:46). Taking a step back, we could also understand the drop in popularity of the bigger GIS projects from the perspective of structural adjustment programs and limitation in state finances causing reduced investment in state agencies. The relative popularity of 'project-GIS' thus went hand in hand with a change in political vision concerning how the state should be organised. Though not totally unaffected by this change[29], Central American governments and donors continued investing in 'big' GIS projects (Gonzalez, 1997). Continuing investments can partly be explained by the strong lobby of, especially the Costa Rican, environmentalist movement for projects on sustainable development (this thesis). This included lobby for projects through the Central American Committee for Environment and Development (CCAD)[30]. The continuation of investments in large GIS could also be attributed, however, to the total absence of nation wide information in most Central American countries, after many years of civil war.

Christiansen (1998:49), while limiting his study to 'project-GIS', emphasises that in the future more research has to be done on the 'institutional' problems of 'corporate GIS'. Also others mention these 'institutional factors', by which they mean regulations with respect to data and data standards, culture, sectoral structure and competence of government agencies, lack of political support, etc. (Hassan & Hutchingson, 1992; Sahay & Walsham, 1996; Fox, 1991; Christiansen, 1998). Fox (1991:60), from practical experience, defines 'the institutional' as both the regulatory arrangements, the rules and laws affected by GIS and their application, and the organisational arrangements of groups of people who are involved in using the GIS, such as e.g., governmental agencies and NGOs. He concludes that

[29]In a study for the Central American governments on GIS for environmental decisions in Central America, emphasis is put on the importance of the private sector for the production and analysis of data for state planning (Gonzalez, 1997).

[30] See for example the electronic newsletters of the Mesoamerican Biological Corridor from the World Bank.

implementation of GIS is not constrained by technical problems, but by social, economic and political factors (ibid.:69). This implies much more attention to organisational and political aspects of GIS implementation.

The discussion of the literature on 'GIS transfer' has made clear that there are technological limitations to be taken into consideration. But most importantly, GIS implementation in more complex organisations, has to deal with the institutional problems in order to arrive at more successful implementation. Practical experience from GIS operators and project managers has pointed to the importance of social and political aspects. Because the literature limits itself to enumerating factors, it does not give insights into more structural and explanatory factors lying behind the problems listed. The structural aspects receive more attention in an emerging literature on organisational and management aspects of GIS implementation.

2.2 Organisation and Management Approach to GIS implementation

The organisational network or management approach tries to improve the implementation process of (in particular) 'institutional-GIS', such as Ministerial GIS applications or National Data Centres. The approach acknowledges the importance of static factors described above for understanding GIS, but points to the importance of more theoretical notions of GIS implementation as a dynamic process (Sahay & Walsham, 1996; Nedovic-Budic & Pinto, 1999; Brinkerhoff, 1996; Barret, Sahay & Walsham, 2001; Azad & Wiggens, 1995). Building on earlier experience of Information Systems implementation these authors try to analyse the implementation of GIS in a structured way to identify potential problems and to guide cycles of adaptation. In general, authors in this tradition ask for more attention for social and organisational aspects during GIS-implementation. GIS is not only a technology but also part of an organisational structure.

Sahay and Walsham (1996), for example, illustrate the linkages between the social context and the implementation process in the case of India's degraded watersheds project. During the project the organisational problems (top-down hierarchies, sectoral divisions) and the difference in perception of GIS (scientific culture/versus bureaucratic management culture) were causing the failure of the project. The interaction of context and process has to be taken into account to understand implementation. Building on Nedovic-Budic and Pinto (1999), I will shortly explain the formal analysis of this 'organisation and management approach', as illustrated in Figure 2.1. The context consists of networks in the organisation and inter-organisational relations. Certain government or donor motivations (like stimulating efficiency) set a process of (coordinated) GIS implementation in action, leading to certain results.

The ‘interorganisational context’ in Figure 2.1 represents the factors that influence interdependencies or linkages between organisations. The linkages can be organised in different ways, each of increasing intensity, ranging from 'information sharing', to 'resource sharing', to 'joint action' (Brinkerhoff, 1996). This in turn determines how dependent one organisation is on the other. According to this ‘organisation and management approach’, the organisational linkages can be structured through hierarchy, or market forms of cooperation. The structure of decision making is influenced by the nature of these organisational linkages. The literature also mentions that changes in organisation can be political because "exchange [of information] is usually sought with a minimum loss of organisational autonomy and power" (Nedovic-Budic & Pinto, 1999:56).

In the framework, the motivation for implementing GIS is most often referred to in economic terms, as cost saving and efficiency, and preventing duplication of data production. Higher authority, common interests, or exchange inducements have been cited as the most important motivations for cooperation among individual actors (Nedovic-Budic & Pinto, 1999; Brinkerhoff, 1996). The ‘process’ of implementation contains discussions on problem definition, direction setting and structuring of the implementation. It involves redefinition of the existing structural rules of data production, responsibility over the GIS and exchange of data, just as the policies to stimulate cooperation (Figure 2.1).

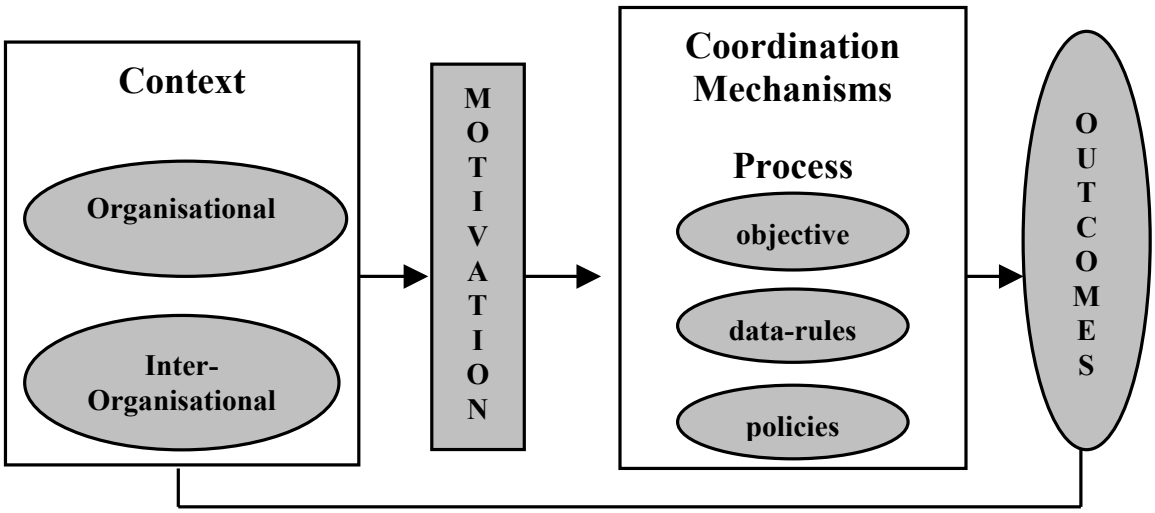


Figure 2.1 Conceptual Framework to GIS Implementation in the Organisation and Management Approach (adapted from: Nedovic-Budic & Pinto, 1999:56)

Some authors emphasise the importance of organisational 'culture'. Rational planning practices that are brought in with the GIS are not transferable easily when there is no 'tradition' of rational planning (Sahay & Walsham, 1996; Burrough, 1992; Barrett, Sahay & Walsham, 2001). Although the problem of culture is part of implementation processes, the

presentation of the problem as a 'Third World problem' is Euro-centric, in the sense that it assumes a logical rational progression towards more use of science in planning, and that other cultures 'just are not that far yet'. Ways of doing things might be different, in the light of e.g., scarce resources, hierarchies or power politics, but often they still can be interpreted as rational for the situation at hand.

Formalised discussion of the implementation process helps us to understand the complexities involved in an 'institutional GIS'. It becomes immediately clear that GIS is more than model building and computer installation. Complex systems and databases are ‘manifestations of the inter-organisational relationships and models of government’ (Nedovic-Budic & Pinto, 1999:55). How much the 'organisational and management approach' contributes to better implementation is still not totally clear. While people who use the approach to evaluate implementation processes come to the conclusion that better management of project cycles and attention to organisational aspect would lead to better implementation (Nedovic, 1998; Sahay & Walsham, 1997), others point to the highly volatile and dynamic nature of GIS implementation and management support (Chan & Williamson, 2000; Montagu, 2000). The latter group thinks that, because of the long term nature of GIS implementation and changing attitudes of rapidly changing government agencies and management, implementation is more dependent on creative GIS brokers than on the advise of implementation managers.

Also, because the formal method for studying GIS is limited to only the technological aspects, and does not deal with actual content (e.g., the planning models built into the GIS), studies are often limited to descriptions of organisational problems and successes, without understanding why things have happened (the approach is blind to e.g., the fact that a specific monitoring model for forestry ran into a boycott because forestry interests were too powerful). Models of government are reduced to forms of organisation without content.

Nedovic-Budic (1998) recognises this problem when she calls for more case studies to answer the 'how'-questions in relation to specific applications. Nevertheless, using her approach (as presented the figure above) does not give answers to the 'why'-question, and does not explain the very mixed success of long-term implementation processes (Chan & Williamson, 2000). Because these studies do not look at the actual content of the models built into GIS, and the political consequences of these models in society, the domain of the 'political' is restricted to discussions of bureaucratic efficiency and the interests of actors protecting their jobs. A GIS practitioner who did research on GIS implementation in Papua New Guinea, Montagu (2000), followed the formal method of Nedovic-Budic & Pinto (1999) and came to the conclusion that although the method offers insight into organisational work-floor processes, it was especially 'the broader political economy of the planning environment' that dictated the success or failure of GIS-implementation. "This is hardly a revelation to the planning discipline, which has long recognised the political context

of the planning endeavour" (Montagu, 2000). The consequences for GIS Implementation are far reaching, though. Because of the importance of the political economy of the topic at hand, GIS projects have to be understood not just as 'efficiency' improving projects, but as part of wider institutional practice and discussions aimed at transforming the activity of planning and environmental regulation itself. The approach that has given attention to these aspects can be labelled 'social aspects of GIS'.

2.3 The Social Aspects of GIS (as an approach)

Human geographers were the first to begin a discussion about GIS in its wider social context. Originally these scholars criticised the 'hype' of GIS, pointing to potential surveillance and privacy consequences (Pickles, 1991 & 1995), and the role of GIS in new ways of waging destructive 'remote control'-wars (Smith, 1992). One of the main criticisms focused on the positivistic aspects of GIS (Schuurman, 2000)). It was noticed that GIS had led to - and often is - a 're-embrace of rational planning' (Pickles, 1995; Lake, 1993).

Many GIS-technologists were well aware of the wider political aspects of GIS implementation. Open access to information, privacy and data quality were seen as elements in good and responsible practice, and through the approach of multiple objectives, practitioners tried to deal with different political options in models (Latesteijn & Rabbinge, 1993; Rossing et al., 1999). Still, the information itself, and the embedded models, are seen as objective, and the goal is to make planning more rational. These GIS practitioners and model builders point to the fact that GIS can help to stimulate practitioners and planners to make well-defined and explicit choices. By doing so, GIS would encourage more transparency. It also would create the possibility to evaluate afterwards how decisions were taken (Eweg, 1994). In 'traditional planning' often choices were implicit, often only an end product would be available, while the process almost never was reproducible (van Lammeren, 1994; Eweg, 1994). So while GIS itself cannot be 'bad' or 'good', the technologists claim that it is only the way in which information and its quality is managed that can be political (Clark, 1998).

Human Geographers reacted to this by arguing that just like computer technology in general, GIS can strengthen the status quo, empower the technically sophisticated, disenfranchise the less technically adept, and bury political choices under technological mystification (Klosterman, 1992, quoted in Lake, 1993). Taylor (1991b) warns that the focus of GIS on data will lead to less attention to the data-poor Third World and its local problems. The claim is that well-intentioned GIS practitioners do not by themselves abolish this threat, because something more fundamental is wrong with GIS (Pickles, 1995). The main critique was very similar to earlier critiques of rational state planning as summarised by Scott (1995 and 1998). Effective state intervention - good or bad - implies the collection of information

and simplification of reality. Constructed 'facts' are meant for specific applications and interests, they are numerical, static and aggregated. Any project for the implementation of GIS in state agencies is part of this process of one-way viewing by the state of its citizens (Curry, 1995). The 'state simplifications' do not take into consideration the variety of citizens, contingency and the contextuality of any intervention.

Questions of only 'good' applications, important as they are, are certainly not enough, because the mere assumption that GIS will offer the solution to a certain problem implies that from the outset, all citizens have to agree with the premises upon which GIS is modelled. Equal access to information is meaningless if the information is only useful for the applications by some groups in society (Lake, 1993).

The critique of the human geographers is important for implementation of GIS projects because it can explain why some powerful actors would try to boycott or promote certain modes of GIS information gathering and application, and can explain why certain groups or solutions disappear with the aggregation of information in models. Politically-intended reform projects and donor funding of projects do not only have consequences for the organisational way projects function, like the project- and GIS-manager experiences, but the funding in itself is political and has to do with stimulation and legitimacy of certain activities.

Literature about GIS implementation starting from these critical concepts is scarce. Most literature on social aspects of GIS can be divided in two classes: literature that follows a theoretical critique giving GIS an inherent 'evil' character, and literature that seeks to participate in GIS design from an alternative point of view (Schuurman, 2000; Sheppart et al., 1999). This last body contains some interesting studies on GIS aiming at more participation in planning (Gonzalez, 2000; van Etten, 1999; Laforge & Torrealba, 1998), empowerment of disenfranchised groups (Nietschmann, 1995), or analysis of war situations (Klaassen & Van Hoeve, 2001).

While the 'organisational and management approach' saw information itself as un-problematic, and the implementation process as limited to the organisation(s) involved, the critique of human geographers pointed out that information is socially constructed, containing certain assumptions about society and the functioning of GIS. Also while managers often only perceive the implementation process as political, in the sense of bureaucratic autonomy, the human geographers wanted to relate implementation itself to the wider context of planning in society (Sheppart, et al., 1999). In a fairly limited literature some of these ideas have been applied in practice. These authors start from the point of the social construction of GIS (Innes & Simpson, 1993; Harvey & Chrisman, 1998; Martin, 2000). They advise that planners and GIS-implementers must look beyond the technical

understanding of GIS, and regard GIS as something socially constructed rather than technically organised (Innes & Simpson, 1993). The information and models in GIS are also part of the social construction process. Information for planning bears a social imprint in a number of ways; in the way the problem is defined, in the limitation of the range of solutions, and in the accountability of the choices (Innes, 1989). Finally, the way in which an outcome is presented, and the ways in which public arguments are made are in themselves social constructions (ibid.). Innes hopes that through organising planning in transparent ways, planners can function as critical intermediaries between state and society[31] (Innes, 1989). It still is difficult to imagine, though, how planners can overcome the power differences of important actors, and how, - even if they try -, they can guarantee equal negotiation rights between different players[32].

Martin (2000) studied the implementation of GIS for environmental management in Ecuador, following the theories of Latour[33]. He defines GIS implementation as a complex process of actor-network building. This allows him to indicate that in addition to the institutional aspects inside the GIS-workplace, successful GIS implementation depends on strong relations with actors outside the organisational boundaries, in donor circles and (other) government agencies. Harvey & Chrisman (1998), also using Latour's actor network theory, focus more on the importance of the content of GIS. By establishing common

[31]This idea comes close to the reasoning of many GIS practitioners themselves, when they argue that the importance of GIS is that it forces explicit choices and transparency of procedures. They also expect that this will lead to at least more accountable plan making, under the condition that the data and expertise is widely available and accessible to all actors. (Clark, 1998; Eweg, 1994; van Lammeren, 1994). Although Innes recognised that all data contain choices and are socially constructed, and that data are not objective, she believes that (based on Habermas' ideas of open discussion and critical knowledge) the rationalisation of planning practice can bring social progress. On a theoretical level these ideas are criticised by Leeuwis (1993) in his book on computer applications in extension. The critique is also relevant for planning. According to Leeuwis, rationalisation is problematic because 1) Habermas' framework seems to imply that consensus is the motor for progress, while consensus among some actors is often based on conflict with others, 2) often it is highly unrealistic to expect that 'a neutral and independent' facilitator could create ideal speech situations, that [also in the setting of planning] probably is misplaced and unproductive, 3) the differentiation between private domain and economic sphere is often problematic, 4) Habermas' definitions of knowledge and knowledge constituting interests seems difficult to maintain, 5) his theory leads often to bias towards structural explanations, and finally, 6) his idea of rationalisation as a process of social evolution is Euro-centric and unrealistic in the light of diversity in society (Leeuwis, 1993;97-100).

[32] These players can be very different in their potential to influence agendas, if we consider, for example, differences between poor farmers, environmental NGOs, chambers of commerce, state- or multinational agencies.

[33] Latour (1987) is probably the most renowned proponents of the Actor Network Theory (ANT) (see also e.g., Callon (1987); Law & Callon, 1992). This theory studies technology and science as a process of actor network building. It takes a radical view on actors, considering both humans and artefacts as equal parts in the actor network. The alignment of actors into stable networks (called convergence) makes a technology successful and accepted. The advantage of the approach is that is gives ample attention to power, money, legitimation as well as the substitution of human activities by technology. The theory is problematic because it ascribes agency to artefacts and nature, and puts these on equal footing with human agency. Given its refusal to engage wider social theory in explaining the existence and role of the networks, and by presuming that everything in the network constitutes actors, there is no room left for causal explanation of why things happen (Van den Belt, 1997). A similar argument can be made about natural objects, which are taken as 'a construction', - only existing once they are established in an actor network - , without inherent causal characteristics.

concepts and definitions (- 'a boundary object' in theoretical terms -) of 'wetlands', a group of GIS users including the US federal government and some NGOs were able to stabilise a network of contacts to promote each others' social agendas for wetland preservation, while excluding groups with other definitions.

These interesting case studies show that the social constructivist perspective is strong in describing GIS implementation, not only as part of the organisational structure, but also as influenced by the outside context. Donor contacts and contacts with important user groups reinforce 'stabilisation' (another jargon-word of actor network theory) of GIS implementation. Further, like organisational theorists, actor network theorists are able to study the importance of definitions of standardised concepts and data. Additionally, the advantage of network theorists is that, because they do not take data as inherently objective fact, they can explain the prevalence and political nature of certain concepts because these concepts are related to a wider network (Latour, 1987). This enables an analysis of the power relations between organisations and wider groups in society involved in the creation, interpretation and use of definitions and concepts, instead of merely describing data in terms of exchange problems and problems of defining the 'objective uses' of data in different applications.

Actor network theory is, - similar to the organisational and management theories of GIS implementation - , weak in explaining *why* things have happened. The real impact of the networks and relations between the definitions of the 'boundary objects' and their social context remains to be guessed. Given the fact that literature on this topic is scarce and the kind of problems mentioned above I think it is necessary to go deeper into discussions of the 'social theory of technology' to overcome the shortcomings of this limited literature on social construction of GIS. At the same time I will seek to build on some of the ideas of the theoretically-oriented social geographers for understanding GIS implementation.

2.4 The Social Studies of Technology and GIS

The literature of the 'social aspects of GIS' approach offers many interesting pointers towards an improved understanding of GIS-implementation. The problems with the approach described above are not unprecedented in discussions of 'social studies of technology'. Problems of too much attention paid to actors, or a too deterministic view, have been discussed extensively in more general literature of the social studies of technology. I will therefore first turn to the wider discussions on social construction of technology (2.4.1), and then end this section with a discussion on how to improve this approach with the help of some concepts drawn from Giddens, who tries to bridge the gap between structure and actors (2.4.2). With this approach I will advance a claim to be able give ‘why’ answers to questions on problems and successes of GIS implementation.

2.4.1 The Social Construction of Technology Debate

To understand GIS implementation problems, and the opportunities and dangers that GIS use implies for land use planning, it does not suffice to say that GIS is 'socially constructed'. Still the social constructivist approach offers a useful starting point. General theories of the social construction of technology (Bijker & Law, 1992; Latour, 1987; Bijker, 1993) give us the advantage of looking at the dynamic developments of GIS without falling into the trap of technological determinism (in which GIS tends to be credited some inherently malign content). This makes good sense in the case of GIS use for environmental resource management, because GIS, as is the case with many IT applications, is very flexible, and its applications are wide-ranging, and defined mostly on a case by case basis. Starting from the human actors involved in the construction process, the social constructivists pay attention to creativity and the influence of a network of relevant people beyond the mere organisation of technology development. The social construction school also gives serious consideration to the artefact itself. Finally the empirical focus avoids the pitfall of generalisations not based on facts[34]. The descriptions often are exciting stories about the political and social influence of powerful actors on choices for development of certain new, important and contested innovations.

This focus on 'new and contested' technological issues during an 'exciting' construction process by 'ingenious scientists', however, is problematic. It carries the danger of too much focus on micro-processes, and the presentation of technology development as a story of negotiations between individual actors. It also pays too little attention to the slow (and - for social scientist perhaps - more 'boring') adaptations and adoptions of technology in use. The focus on micro processes of constructivism risks excluding structural elements in the analysis. Structural aspects, such as culture, class or power, are left out of the picture (Winner, 1993; Winner, 1985; Orlikowsky, 1992; Rammert, 1997; Hård, 1993). The construction process of GIS in planning agencies is often not an isolated and totally new process, because it is influenced by structural aspects of the way the software works and limits questions. In part, it is determined by ideas how to deal with certain land use questions through existing scientific ideas, and it has to deal with pre-existing planning practice. This is why it is not surprising to find that GIS often is “constructed” within an already existing 'old fashioned' mapping and zoning approach (Goodchild, 1998), similar to the development

[34] One 'over-generalisation' was that GIS is always a military surveillance technology (e.g., Pickles, 1991). Goodchild, a key person in the GIS world responded with slight irritation to these accusations by human geographers (Goodchild, 1995). Others suggested that the accusations were made in the light of the success of GIS scientists in attracting scarce funding for academic geographical research, and that these accusations were meant to defame GIS-scientists, while defending the relevance of human geography as a discipline (for this argument see Schuurman, 2000).

'trajectories' or 'path-dependencies' found in other technological areas. Path dependence means that earlier choices of technology development limit different conceptualisations and organisation of development outside the developed earlier steps (Schot, 1998).

Further, because social constructivists limit the study of construction processes to a 'relevant social group' or network (Bijker, 1993), the theory carries the danger that some actors who are affected by and/or are absent from the network - can be easily overlooked. The technology development is often described as a neutral process of intentional actors, similar to political theories of pluralism. Structure and direct social consequences are left out, just as the impact that technology development could have on its broader context (Winner, 1993). In GIS research on the construction of 'boundary objects' of Wetlands in the USA (Harvey & Chrisman, 1998) no questions are asked, for example, about the consequences of the participation of the environmental organisation 'Ducks Unlimited', which wants to preserve nature mainly for duck hunting purposes. No questions are posed about how the participation of this group affected (traditional and other) hunting practices (or any practices for that matter).

To overcome such problems associated with social constructivism, this thesis will look for ways to combine aspects of the constructivist approach with more structural approaches to the analysis of technology development. The problems of constructivism, and its micro-focus, are typical, in fact of old problems and discussions in technology studies about the relation between structure and actors (Tranvik, et al., 1999; Rammert, 1997). Orlikowsky (1992) uses Giddens' notion of structuration (Giddens, 1979) to come to a conceptualisation of technology construction that pays attention both to structural aspects of technology and to human actors. Her solutions are very useful for this research and will be expounded and expanded upon later.

2.4.2 'Techno-structuration' of GIS implementation

In her original use of Giddens' structuration theory for technology studies, Orlikowsky (1992) shows the advantages of this theory over more socially- or technologically-deterministic approaches. In this section, I will explain her adaptations of Giddens' ideas for the area of technology studies, because her explanations help overcome a too techno-deterministic or too humanistic approach to technology studies. Since her study focused on computer technology in one organisation, I will slightly modify her approach. To enable analysis beyond the organisation of GIS implementation, I will add the idea of 'coupled technological systems', from Rammert (1997). As we will see below, he explains (also drawing on Giddens) how different technologies can be coupled into complex 'techno-structures'. This idea is relevant, because GIS 'as such' is an empty computer with software,

so its application field (and for example methods and technologies of planning) have to be included in the analysis. With these slight adaptations, I consider Orlikowsky's schemes a useful starting point for setting up a framework of factors to be analysed in this research[35].

In Giddens' theory of structuration, the domain of study "is neither the experience of the individual actor, nor the existence of any form of social totality, but social practices as ordered across space and time" (Giddens, 1984:2). This focus on practice gives the theory a dynamic focus necessary to understand change, but instead of defining practice as actions by present actors within a 'seamless web' (e.g., Bijker, 1993), Giddens defines practice as the interaction of actors with structural properties, continuously used, transformed and redefined (Giddens, 1979). "Through the regular action of knowledgeable and reflexive actors, patterns of interactions become established as standardised practices in organisations, e.g., ways of manufacturing a product, coordinating a meeting or evaluating an employee. Over time habitual uses of such practices eventually become institutionalised, forming the structural properties of organisations" (Orlikowsky, 1992:404). These structural properties are drawn on by humans in ongoing interactions. This is in line with anthropological approaches to the study of technology, which see technology development as an aspect of daily practices and implicit adaptations and negotiations in work processes, construction of meaning and contextualisation[36] (e.g., Ingold 1998; Pfaffenberger, 1992).

In interaction, actors produce and reproduce structural properties that can be conceptually divided in signification, domination and legitimation. The communication of meaning [signification] in interaction does not take place separately from the operation of relations of power [domination], or outside the context of normative sanctions [legitimation]. All social practices involve these three elements (Giddens, 1979).

[35] I must emphasise that the choice of this theory is also one of convenience. Other theories not considered here would argue along similar lines about coupling human action and institutional or cultural properties (for example, Douglas' cultural theory (1987) or Bourdieu's habitus theory (1989)). Following Sewell (1992), Van den Belt gives a useful interpretation of Giddens' theory for the field of science and technology studies (1997). On important adaptation to the theory is the redefinition of resources as *actual* nonhuman objects (for example, cows, land, computers) and human resources (such as, physical strength, or expertise in GIS software), instead of Giddens' more obscure definition of resources as 'the media whereby transformative capacity is employed as power in the routine course of social interaction' (Giddens, 1979:92). The advantage of this redefinition is that it gives the opportunity to understand 'structure' as both 'actual' (resources) and 'virtual' (rules) (ibid.). Van den Belt also positively evaluates Sewell's interpretation of 'rules' as 'cultural schemas'. In this interpretation, human agency is not merely individual, but also profoundly collective. I subscribe to Van den Belt's interpretation, in which the commonalities with Douglas (1987) or Bourdieau (1989) are obvious.

[36] In fact, Ingold (1998) insists on seeing technology as "embodied", which calls into question the entire social constructivist argument.

Level of Interaction	Communication	Power	Sanctions
Medium	Rules of Interpretation	Resources	Normative Rules
Structural Level	Signification	Domination	Legitimation

Figure 2.2 A Conceptualisation of the Relation between Structural Properties of Social Systems and Human Action (after: Munters, et al., 1985:87)

Orlikowsky defines technology in a narrow sense as the material artefacts, which permits a contextual analysis of technology development and use[37]. In a similar vein we will define GIS as a tool or artefact, excluding organisational aspects from the definition. First by pointing to the 'duality' of technology, and the time factor, she recognises both the socially constructed character of technology, - be it limited by its structural context - and the structural properties of technology, once it is accepted, deployed and used. She can, to a certain extent, explain the traditional difference in social studies of technology as part of this duality in itself, with the social constructivist putting more emphasis on the design of technology and the technological determinist more on technology in its use after implementation. In practice, once technology is implemented it might appear (or is) much more fixed, because it has already been intertwined with the structural characteristics of an organisation, which makes it more difficult to change (Orlikowsky, 1992;406-407)[38].

Building on the time component in the development of technology, Orlikowsky suggests making an analytical difference between a 'design mode' and a 'use mode'. Although in practice the difference is difficult to make, in the case of GIS-implementation it still might be useful. Granted, the implementation of computers and GIS is at the core of this design mode. But the activity of GIS-implementation is also part of a wider process of land use planning and regulation, which is in a continuous design and use mode. As we have discussed before, GIS-implementation involves, besides implementing computers, also defining data, models and possible uses of the expected products of the GIS. Because GIS implementation cannot be considered as only the implementation of computers and some software, implementation has to be seen as a more complex process of 'coupling' technologies of GIS and planning. In the sense that GIS implementation is part of the ongoing process of planning and regulation, it can not be considered as being merely in a

[37] In her article she emphasises, however, that technology or the artefact should not be understood as merely the physical object. "..overloading the technology concept [with social and organisational characteristics] is unnecessarily limiting,…the analytical decoupling of artifacts from human action allows me to conceptualize material artifacts as the outcome of coordinated human action and hence as inherently social. It also facilitates my framing of the role [influence or impact] of technology in terms of mutual interaction between human agents and technology and hence as both structural and socially constructed" (Orlikowsky, 1992:403).

[38] In the language of Mary Douglas (1987) it has come to be a "culture".

'design' mode. By taking both processes into account, I will be able to 'contextualise' the GIS implementation process not only as part of organisational change (as in the theory of the management approach), or as part of a network of stakeholders (as in the actor network approach), but as part of the wider context of the application of GIS itself.

Orlikowsky's structuration model of technology comprises the following components: 1) human agents (technology designers, users and decision makers) 2) technology and 3) structural or institutional properties (structural arrangements, culture, rules and regulations, division of labour, etc). Orlikowsky (1992) explains the development of certain items of productive software technology within a firm. Her focus is on the regulative aspects of the software in the work process of the organisation itself. Most technology studies focus on work processes and the direct production of things, or on organisations. Because of the nature of GIS as regulative technology we need to adapt the structuration model that Orlikowsky suggests. In contrast with productive technologies, technology for regulation is designed for influencing humans beyond the organisation of technology implementation/development. This is another reason why it is important to take the application of GIS (planning and regulation models and methods) into consideration. I will call this combination "coupled 'techno-structures'" (Rammert, 1997).

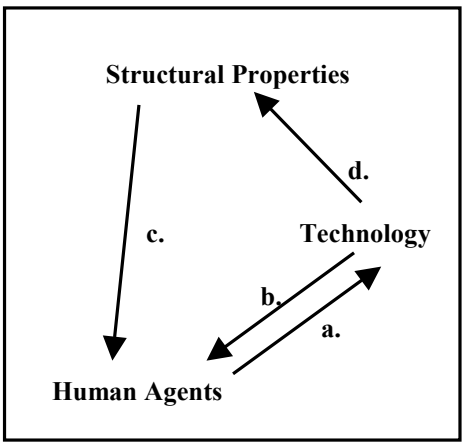


Figure 2.3 Techno-structuration of Technology in an Organisation (From: Orlikowsky, 1992)

a. Human agents can influence technology in several ways. In the use mode technology can be given different meanings and uses, while in the design mode actors can influence in the design requirements and build in requirements of use.
b. Technology influences human agents by constraining and enabling certain activities
c. Structural properties condition human interactions following existing rules, norms, knowledge and resources.
d. Technology influences institutional properties in that its adoption is conditioned on the organisation's structure of signification, domination and legitimation. The use of technology can, therefore, change or reinforce institutional properties.

Rammert (1997) calls the process of technology design and use 'techno-structuration'. Technologies have to be understood 'relationally' as a particular social process of relating

things, signs and human agents. Technologies should be understood not outside of society, but as 'technostructures' within the stream of social action in context (Rammert, 1997). Because the implementation of GIS in land-use planning and regulation affects more than only the organisation or agency in which the GIS is implemented, this thesis has to deal with the coupling of different 'techno-structures', of land use planning and GIS. GIS is not only making changes in the work processes within the organisation were the GIS is implemented, but it also involves changes in planning and regulation of land use in a wider context. GIS not only changes the practice of map-making and models through the introduction of expert systems, but also changes the potential of, for example, enforcement in land use planning through satellite monitoring. Also, the models in GIS for determining new agro-ecological zones can become a materialised representation of rules for decisions on who gets credit and assistance from a state extension agency.

By combining the dual aspect of GIS-design and its use as part of the wider context of land-use planning, we can avoid the techno-determinism (with an overemphasis on the 'use side' of GIS technology) of some human geographers, while at the same time dealing with the limitations of management and network approaches (with an overemphasis on the mere process of computers and software). With this approach, we can ask questions such as when and under which conditions GIS might be used as surveillance technology (Pickles, 1991; Sheppard et al., 1999), and how (and why so) it will have an impact on planning .

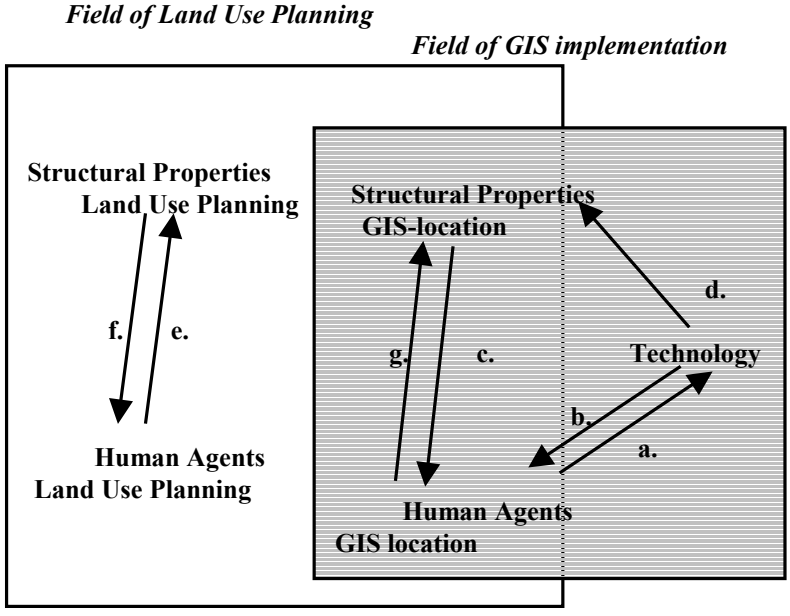


Figure 2.4 Techno-structuration of GIS for Land Use Planning

If we want to apply this structuration model, we will have to adapt the scheme above to include extra-organisational institutional properties and human interactions, by the coupling

of the different techno-structures of the field of land use planning and the field of GIS implementation. The institutional properties that are affected and brought into play are wider than those of the mere location of technology construction.

By adding the wider structural properties, I want to draw attention to the existence of contextual factors and dynamics that bear influence on human agents involved in GIS implementation. There are rules, norms, resources, knowledge, culture, etc, beyond the organisation of the individual GIS location. These factors and dynamics are part of the wider application field of GIS (the field of land use planning). The overlap indicates that the structural properties of GIS implementation are part of the wider field of structural properties of all land use planning activity. Approaching GIS implementation with this approach enables us to include, for example, law making, or current knowledge and discussions about the environment as factors that dynamically influence the structural properties and human agents in a particular GIS-organisation.

Orlikowsky's figure needs improvement in one aspect. By adding a direct arrow (g) from human agents (e.g., technology designers, users, decision makers and foreign consultants) within the organisation of GIS construction to the institutional properties, I want to indicate that structural properties can be modified or changed, before any technology is designed/implemented. Technology implementation is not the only means through which GIS builders influence the institutional properties of their organisation. The example of the Wageningen University project from our introductory chapter comes to mind. Reorganisations in the Costa Rican Ministry of Agriculture had deep implications for its internal organisation and accepted 'models of planning'. As we will discuss in one of the case studies, personnel from the Ministry lobbied strongly for different ways of re-organising responsibilities. These reorganisations implied that within the Ministry there was no demand for the 'policy GIS' of the Wageningen project. This clearly affected the whole process of the Wageningen project's GIS 'transfer'.

Similarly, in studying GIS implementation, we have to be able to include the influence of planning's structural properties on agents in the 'field of GIS implementation' and vice versa. Agents of GIS implementation are often also agents in the wider field of land-use planning as members of committees, consultants, or maybe even as land owners. In such activities, they confirm and change existing structural aspects of land-use planning (arrow e), and are influenced by changes in the wider properties of land-use planning (f.). The complex relation between the two 'technostructures' can be illustrated by the fact that many projects for GIS implementation are in reality embedded in larger land-use planning projects (resources going through 'f' to human agents of GIS via human agents in the field of planning). Also, many GIS projects are often not merely aiming at implementing a computer, but have explicit (and implicit) goals for improving the overall efficiency of, for

example, all planning activities in a Ministry or even a sector (PASA, 1991a). Note that I do not include a separate item ‘technology’ (with its arrows) for the 'techno-structuration' of land-use planning methodologies, as this is not my topic of study. I will take the dynamics in land-use planning methodologies, more at face value and will evaluate this only in relation to the GIS implementation process.

By taking note of the wider context, it becomes possible to discuss more extensive social and technological influences on GIS construction, and the consequences GIS has on reshaping that wider context. It will enable us in the discussion chapter to ask more general questions about the nature of changes in the structuration process of land-use planning itself. The next section will answer how these insights were used to formulate the methodological approach adopted in this research on GIS implementation.

2.5 Methodological Issues

Lessons from the Wageningen Project: Implementation as daily practise

What are the methodological lessons from the attempts of Atlantic Zone Project of Wageningen University to 'transfer' their models to the Costa Rican Ministry of Agriculture? As we saw in Chapter 1, the Wageningen project in Costa Rica adopted a positivist policy of strict separation of science and politics. The GIS and models would be first developed, and, later, government agencies would be able to use them. After the first interaction experiences and, later, training sessions, the Wageningen project discovered several 'transfer problems', similar to those mentioned in the international literature. The Costa Rican counterpart had, for example, lost the digital soil map generated by the Wageningen project, over three times, and the models were perceived as too complicated for the actual Costa Rican situation. Experts trained with Dutch money left the Ministry of Agriculture, while the Dutch government did not come through with promised donor money for GIS training of an expert at the Tropical Agronomy Research and Higher Education Centre, CATIE (Wielemaker, *Wb-magazine 1999*). During the very late 'transfer process' of the Wageningen land use planning model a sociologist 'discovered' that transfer was difficult because of 'institutional problems' (Mera, 1998a&b). The organisational and management literature would have been able to tell Wageningen scientists that their model and GIS also required reformulation of the way data was defined, collected and managed, and that for the case of the complex organisation of the Agricultural Ministry this would mean redefinition of responsibilities between policy, research and extension departments. Maybe the model of Wageningen was not as relevant as it had been billed.

But the problems ran deeper, as the literature of the critical geographers shows. In defining GIS and models as socially constructed, attention shifts to the importance of networks for

building alliances over GIS practices, definitions of problems, and concepts. Mera (1998a&b) discovered during her study on the Wageningen transfer process that the Wageningen project cooperated only with a relatively isolated group in the Ministry of Agriculture. This group was 'married' to other models (and practices), and it therefore soon discarded the sophisticated model of the Wageningen project. Taking it even a step further, the whole discussion on GIS implementation and model choice was part of a political reorganisation process of the Ministry of Agriculture, and on land use regulation in general (this thesis). The situation we discussed can only be understood by considering implementation as part of daily practice of interaction within a dynamic changing context.

The Wageningen story illustrates the importance of the theoretical approach preferred here. It also shows that to understand implementation we have to start from practice. This is the reason why we chose to make case studies central to this research. By looking at daily processes and their context we will seek to understand and prevent the errors of the Wageningen project. This thesis will use three case studies to answer the '*how'* and '*why*' questions of GIS implementation, which – as we have seen - are difficult to answer adopting the dominant approaches as discussed in 2.1-2.3. The choice for a multiple case study approach further permits a comparison of implementation processes, and the evaluation of structural influence from the wider field of land use planning on GIS implementation, as well as the influence of more general aspects of GIS-technology on structural aspects of planning.

From the overview of GIS-activities, made at the start of my research I selected three government agencies implementing an 'institutional GIS' for land use planning and regulation; the Department of Land Evaluation and Soil Science in the Ministry of Agriculture, the office for forest monitoring of the Ministry of Environment and Energy, and a government project for the creation of the National Geographical Information System implemented as part of the work of the Ministry of Planning. The cases will be discussed in separate chapters (5, 6 & 7), while a comparative analysis will be made in the concluding chapter (8).

Costa Rica as the 'model' Case

The choice of Costa Rica as the country for my research was partly motivated by the Wageningen project. Its importance for the university, and its problems, were good reasons to start this research. The choice of Costa Rica as a case study was important in two ways, beyond the simple fact of a 'Wageningen connection'. Compared to the rest of Central America Costa Rica is relatively advanced in GIS developments, and is internationally known as an exemplary player in environmental protection and sustainable development (Wallace, 1992; Hall et al, 2000a).

It is important to draw lessons from the experience of the developments in GIS of Costa Rica, given its relatively privileged position. Costa Rica has always participated in major international projects (World Bank, UNITAR, Canadian Radar Project 'Globesar', etc.) , and organised the first Latin American Conference on Informatics and Geography in 1987 (Moneeyhan, 1998; Aguilar & Elizondo, 2000; Leyw, 1987). It also has the major regional GIS-training centres at the Tropical Agronomy Research and Higher Education Centre (CATIE) and the National University (a development and training centre for the popular software 'IDRISI'). Costa Rica is often mentioned[39] as an example for Central America, for promotion of GIS, the implementation of state data information systems, and lessons for information policy (Gonzalez, 1997; Hall et al., 2000; IADB, 1998).

On the environmental front Costa Rica is also internationally recognised as a model for Latin American countries (e.g., Wallace, 1992; World Bank, 2000; IADB, 1998; Jansen et al., 1994). From the early nineties GIS became central in these environmental discussions, as we will see later in the case study chapters. In 1994, the Figueres government presented itself as the first country in Latin America actively to promote Sustainable Development in all its policies. As an important first step it would follow the chapters on information production, exchange and use, following “Agenda 21”, of the United Nations Conference on Environment and Development (UNCED) (Chapter 7). With the help of GIS and new soil maps, it would transform its agriculture through 'conservationist' production systems (Chapter 5). At the Kyoto conference on Climate Change in 1997, Costa Rica presented the fruits of these efforts in the form of a GIS model for monitoring of forests and estimating carbon fixation capacity (Chapter 6).

Granted this lively interest in information use for land use planning, and with its technological capacity in GIS, Costa Rica clearly constitutes an important case for examining the opportunities and problems of GIS implementation processes. To what extent lessons from Costa Rican cases can be extended to other countries will be discussed in the last chapter of the thesis. The fact that Costa Rica is often mentioned as a model implies these lessons are already considered relevant. There is already an established interest in international fora of GIS developers, donors and decision-makers, which will make the results of any research on Costa Rica more readily heard.

[39] During several interviews with officials of international financial institutions the aspects mentioned in this paragraph were often cited supporting Costa Rican projects (IFI1, 24-07-97; IFI2, 20-10-97; IFI4, 4-11-97).

Research Methods

When I first arrived in Costa Rica, I was surprised in two ways, in relation to my original goals of research. I visited many GIS projects in universities, NGOs and government agencies, to get a quick overview of the 'GIS landscape' of the country (Annex 1). My questions[40] were focused at first on the applications of GIS, the motivation behind the topics of study, the cooperation networks and the historical background of each GIS location. This inventory made clear that there was much more 'GIS-activity' than I had expected, but secondly, that the GIS-activities did not show the sophistication of 'analysis' and 'model building' I was aiming to study in detail, as specified in my original research proposal. The expectation that I would be able to do complex analysis of the construction of GIS models, errors, their build-in ideas and changing conceptions proved to be illusory. Indeed, as in other parts of the world (Goodchild, 1998; Simonett, 1993), applications were mostly map-based and focused on databases, simple overlay and monitoring. This was probably what the Wageningen project meant when I was warned that hardly any 'real' GIS was present in Costa Rica[41]. There was much more continuity of old ideas, but also GIS itself was more than the constructed model I thought to analyse. GIS often also meant money, and sometimes prestige, and was part of an important dynamics of organisational change and national level discussions about land use planning and regulation in general. My original approach to doing case studies was therefore not irrelevant, and became only more interesting, because each case could also say something about the others. Ideas about techno-structuration and "cultures" of technology helped put these findings in perspective and organise the research.

Looking back at Figure 2.4, GIS inventory proved a significant part of the context, as the level of technology development, training and data-infrastructure are important enabling and

[40] The questionnaire contained a list of topics to be crossed off when dealt with, and reporting was done on the answers, but also on all conversations around the answers. Instead of formal questions, 'empirical questions' (can you give an example of successful use of your GIS products?) and 'strategy questions' were posed to prevent 'textbook' answers. In his own participatory research, Simonett mentions the severe problem that GIS operators' answers often echo textbooks (GIS should be used for x,y,z) or 'ideas he himself had given them before'(1993:8). With my 'empirical' and qualitative approach I also prevented 'nonsense data interpretations' that often occurred in earlier quantitative inventories (e.g. Junkov 1993a&b; Gonzalez, 1997). Junkov for example concluded that Costa Rica had more severe problems with data production than other countries. At the same time he mentioned that Costa Rica had more information than other countries in Central America. His data on Costa Rica was based on only 8 formal answered survey forms. Although Junkov described some of the limitations of his study on Costa Rica in the main text, his conclusions focussed exclusively on the tabled answers (with - often incomparable – 'non-information') of the survey. This led to overinterpretations of his survey data and dubious recommendations. A preliminary report of my inventory was made by a research assistant (Diaz, 1997b).

[41] It also proved that the Wageningen project had the same expectations of GIS models, and saw map making and simple overlay as inferior, i.e. not 'real' GIS practice ('real' in this case meant 'analytical' and 'complex modeling' applications of GIS).

limiting properties for the development of individual GIS projects. After my first inventory conducted using semi-structured interview formats, I stayed in close contact with some main GIS departments (of two universities and two projects) involved in promoting information exchange and national cooperation. In addition to many conversations and formal interviews, I attended discussion meetings on national data production and exchange and collected documents of individual GIS projects and earlier GIS inventories. Finally to understand the background of each case study I interviewed funding agencies, and government actors involved or affected by GIS projects, GIS developers and users. This overview helped me to understand the technological possibilities and limitations of the case studies, as well as the relations of the case study GIS departments to the wider 'GIS-landscape' of Costa Rica.

To contextualise the applications of GIS, and to get a better insight into the structural properties (ideas, land use laws and regulations, division of e.g., economic and human resources, etc) of the activities of the cases, I also undertook a historical study of land use planning and regulation. The historical study encompasses the development of scientific ideas and discussions, and the structural changes in planning regulation by the state, but also considers actors trying to influence the practice of regulation. The start date for the historical overview is the 1970s, because it was in this period that the first initiatives were developed to create a national land use planning system. Study was mostly done through literature search on Costa Rican sources, supplemented by some international literature. Formal and informal interviews with older persons involved in the early period of land use planning and regulation helped me to understand and interpret this local literature. I have maintained contact with several of these people, who have become in effect key informants for my research. The history of planning shows the continuities and changes in planning ideas and practices forming the background for information demands and the models built into the case study GIS. It also showed that different planning ideas existed side by side, related to the interests of different pressure groups. How these different ideas influenced GIS construction depended on the more recent political developments, and specific features of each case study GIS department. To understand political developments, I analysed for each case study more recent government plans for institutional change and contrasted it with actual developments. With help of discussions in newspapers and interviews in the relevant three Ministries I reconstructed the main choices addressed in institutional change. I show how these choices in turn have had implications for information demand and GIS construction[42].

To understand the actual GIS implementation, I first reconstructed a detailed history of the origins of the GIS from documents and interviews, and then followed up the further development of the databases, models and institutional location from as close a perspective

[42] Annex 2 gives a categorisation of interviews held for this research

as possible. In two case studies I was a participant observer in some of the main decisions on the GIS development, and with detailed field notes was able to reconstruct how the actual decisions were shaped by personalities and interests in the context of the institutional developments mentioned above. The third case was studies form formal and informal interviews, newspapers and documents.

As a result of contacts made during the first inventory I was honoured to be invited to participate in the presidential steering committee for the National Geographical Information System (TERRA). I saw this as a unique opportunity to study this case 'from the inside'. As a participant observer in weekly meetings I could describe the developments and discussions from close quarters. Because the invitation came in the early period of my fieldwork, it took me some time (working on the wider context) to better understand what was going on. Because of the detailed descriptions I made in the meetings I was able retrospectively, to reinterpret many interesting discussions. In 1998, during a last visit to Costa Rica, I received feedback on my findings.

I was also able to participate from close quarters in the case of the Ministry of Agriculture. The Costa Rican Office of the Interamerican Institute for Cooperation in Agriculture (IICA), my guest-institute, started an assistance project on GIS implementation during the second half of my fieldwork period. When I walked into the Costa Rican Office looking for some totally different information, they were just discussing how to set up their cooperation with the Ministry of Agriculture. They were as surprised as I was about our common GIS interests, and I gladly accepted an invitation to participate in the project. They were happy with my presentation on the overview of GIS-activity in the country, and the more theoretical aspects of GIS implementation, while I was more than willing to sit-in on the discussion meetings on GIS use in the Ministry of Agriculture. I also was able to collect all discussion materials throughout the project life. Through this project I also was able to deepen my contact with some key players in the Ministry, with whom I had several interviews to understand the historical background of some key choices made during the early development of their GIS. Even after my return to Wageningen, I was able to continue my discussion on GIS implementation with some of these persons through E-mail.

My third case concerns the development of a system for the monitoring of forestry activities. It was hoped GIS would help monitoring forest land use and regulation. The introduction of GIS went together with a total reorganisation of forestry regulations and relevant state institutions. The case was widely discussed in national news media, which helped me follow developments. To study this complex case I started with a study of an NGO highly influential in shaping the new institutional arrangements, and in the generation of a technical GIS for forest monitoring as part of Greenhouse Mitigation Activities. I made my study of this case through several formal interviews and collection of documents. By studying

networks around the NGO I was able to understand how important this NGO was in government circles. Afterwards I conducted several interviews within official state forestry institutes to understand the transfer of the NGO model to the state system. For this case study, I also supervised two Wageningen students, who studied the practical usefulness of the specific GIS models for forest management planning. In 1999, a research assistant collected some extra materials relating to this case in Costa Rica. Because I was not able to participate directly in meetings on the creation of the system, the character of this case study is different from the other cases, in that it is based more on formal documents, newspaper items and interviews.

When writing up the first results I sometimes had to perform internet searched for missing information. As the Costa Rican state was eagerly experimenting with the introduction of websites and information technology the internet was an important source for checking some of my earlier findings. This was especially useful for the forestry monitoring case, as this case was presented widely in international fora. The internet searches also helped me to keep 'up to date' with respect to the other case studies, by looking, for example, at the follow-up development of legal proposals and discussions in the newspaper about certain topics. Finally, in 2000, I had several E-mail interviews, with people directly involved in the GIS projects, to discuss some specific questions and get feedback on my findings. The fruits of my labour have become the text for the remaining chapters in this thesis.

3

Costa Rican Planning Models in Historical Context (1970-1998)

Introduction

The problem this thesis addresses is the fundamental failure of most GIS implementation projects to take the general context into account. Often GIS implementation projects only look at the technical factors of GIS, and stop short of considering social, institutional and cultural aspects of implementation. In the theory chapter we discussed the importance of the social and historical context for implementation. The theory outlined that the way in which the contexts shape the concepts and 'models' of planning will influence the shape of the information gathering and GIS. A highly centralised planning context could, for example, reinforce the creation of information on a central level and a higher level of generalisation, while a conceptual planning model that starts from the premise of decentralised and local planning would need more disaggregated information. Also, the ways in which the steering mechanisms for planning are organised within a state system will influence the demand for information. For example a centralised state organisation could put the locus of control, and hence its information systems, close to a Presidents' Office, while a strongly sectoral bureaucratic state system would divide the information production responsibilities among sectoral lines.

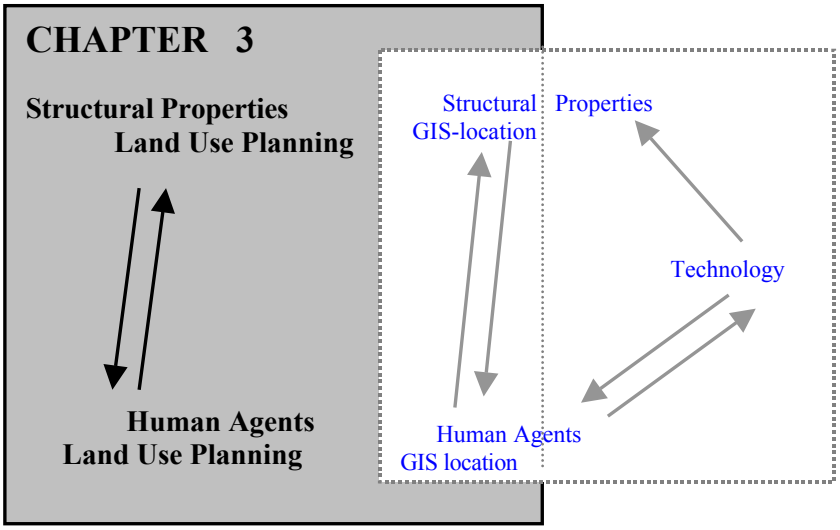


Figure 3.1 The historical background for the techno-structuration of GIS in Costa Rica

This thesis argues further that, in order to understand implementation processes, it is necessary to take a step further than only considering the organisational context of the GIS projects itself. I argue that it is necessary to study the content and definitions of concepts within a GIS for planning, as well as the context of the broader field of planning. These wider contexts are important both in time and space. Ideas of planning, models of planning and institutional focuses all are dynamic and change over time. They are also specific for the country in question. For this reason historical developments have to be taken into account. Land-use planning and regulation are based on 'conceptual models' and ideas about planning. The overall planning models generated from these ideas are related to the political, economic and social organisation of society, and not just to the biophysical environment (as technological determinists often assume). All of this complicates the task of understanding the wider context of GIS implementation. We have to deal simultaneously with an historical overview of shifts in ideas, their translation into organisation of planning and application to policy.

In this research three case studies are employed. Each case considers GIS implementation in a different ministry. While GIS implementation only started in the 1990s, the planning discussions and the institutional practices stem from earlier periods in history. Although the case studies only describe the period of the 1990s, this chapter is important because each of these ministries had its roots in different planning philosophies and promoted different steering mechanisms. Also, their institutional embedding took place at different moments in Costa Rican history. For this reason we have to look at the political history of Costa Rica to understand the development of state institutions and the role of these three ministries. The first part of this chapter is dedicated to this task. Important in this first section (3.1) is the relation between the executive (president and ministers) and its bureaucracy, and the 'role of the state' that the executive is promoting with its government programs and projects. As GIS projects are potentially changing planning practice, as we will see in later chapters, relations between the executive and the state bureaucracy in these projects can deeply influence the way GIS-projects develop. In this first section (3.1), I therefore will deal with the questions of how to understand the Costa Rican State

In the second part of this chapter (3.2) we move to understanding the dynamics of planning discussions and their application in practice over time. This includes 1) a discussion of the main international and national factors influencing planning discussions, 2) an historical overview of the dominant land use planning models and their application through projects and programs and 3) the implications of these developments for institutional reforms in information production. Through a discussion of these three issues we will become aware of a shift in the general planning philosophy over time and consider how and why these changes took place over three decades (Table 3.1). We will also see that the three Ministries played a specific role in these changes. In the end, we also will be able to answer who the

important actors are in the different sectors. Only then will we be in a position (later), to understand the discussions around the kind of applications envisioned during GIS implementation in the three case studies. Taken together this chapter on the history of planning in Costa Rica provides us the broad basis of the contextual factors which will be at the centre of each case study.

The historical overview of planning in Costa Rica featured in this chapter has been established on the basis of my fieldwork interviews, and archive and documentation reviews. Resources drawn on to achieve the overview include many documents and maps from information projects, government and consultancy reports, interviews with key persons involved in planning (1950-1998), newspaper articles, and a large amount of other 'grey literature'. For the first part of this chapter I used concepts from Dunkerly (1988), Wilson (1998), Edelman (1999) and Rojas (1989), in their analysis of Costa Rican political history, borrowing and adapting these towards an historical analysis of the state's role in development planning.

Table 3.1 Historical Changes of Planning Models in Costa Rica 1970-1998

Planning Themes	**1970-1978** **Central Planning**	**1978-1990** **Structural Adjustment**	**1990-1998** **Market Regulation**
Regionalisation	Homogenous intervention areas for centralised decisions on inter-sectoral planning and coordination One regional division	Efficient decentralised intervention areas with regional participation mechanisms. In practice project-planning and two regional divisions	Abolition of intersectoral regional coordination. Search new regional/municipal groupings for attracting investments and environmental management
Centralisation	Central decision making Decentralisation (of tasks)	Central decision making Regional participation	Decentralised market regulation by municipalities; later in 1994 central regulation.
Intersectoral/Sectoral	Intersectoral planning for overall development goals	Some intersectoral coordination. In practice sectoral focus	Sectoral market regulation. Attempts to make environment the intersectoral regulator
Natural Resources	Seen as sovereign national resource for public good. Involvement state in its use.	Seen as national resource, with public-private responsibility	Seen as a global resource with state guaranteeing access for private sector
Public/Private	Public involvement in strategic resources Support of national private sector	Public involvement reduced to supportive role and more private sector involvement	Public sector as regulator that conditions market and strategic attraction of private long-term investments
Information Projects	Centralised, strategic for public investments	Sectoral project/crop wise Export oriented	Monitoring and guaranteeing market functioning/ healthy environment. Information services.

3.1 The Costa Rican Policy Context

In this section, I will first give a historical background to the political shifts in the first half of the twentieth century which led to the creation of Costa Rican democracy. Subsequently, I will describe the influence this had on state formation and its subsequent development up to the seventies. Finally, I will look at the recent history of state reform as a consequence of the political and economic shifts during the eighties and nineties. The Costa Rican state survived this last period of structural adjustments through reinventing its tasks as coordinator for development processes.

In Latin America, Costa Rica stands out for its long democratic tradition, the absence of an army and high investments in a social welfare system (Rojas, 1989). The Costa Rican welfare state has been very successful in creating high levels of literacy and health care, free and accessible for nearly ever citizen (Rojas, 1989; Rivera & Güendell, 1989; Dabene, 1986). Wages also have been substantially higher than elsewhere in the region. Although income distribution is still very skewed[1], the economic success of the country enabled the interventionist state to guarantee a stable social system. Since the early 1980s, however, the system has become under pressure because of the country's debt burden.

Costa Rican economic success can partly be explained by its fertile soils, climatic diversity and geographical location (Hall, 1985). The rich biodiversity is caused by this variety in geographical conditions, and by the fact that the country is located at the connection of two continents (Hall, 2000). The diversity in geology and the biodiversity has drawn the attention of many nature lovers and scientists, who wanted to study the richness of minerals, the vegetation and fauna, and enjoy the beauty of the country[2]. Geographical factors also were important reasons for opening the Organisation of American States' *School for Tropical Agriculture* in 1942, which gave the country a central place in scientific discussions and in experiments in agriculture and natural resource management[3] (IICA, 1992). The country was a pioneer in coffee and banana production and until present has remained an important producer of both crops (Hall, 1976; Bulmer-Thomas, 1989).

[1] Dunkerly (1988) remarks that the social system is certainly not a product of better distribution of income.

[2] The scientists were not only nature lovers, but also adventure-seekers looking for commercial profit from new plant material or mineral resources (Hecht, 1995). An example in Costa Rica was the geographer/botanist Henri Pitier, not only founding father of Costa Rican topographical mapping, but also a renowned plant collector. Around 1904 he helped the 'railway builder' Minor Keith to set up the first banana and cacao plantations along the railroad tracks, initiating an economic boom with this 'green gold' (Conejo, 1975). For other examples see also (Rodriguez, 1993)

[3] This school is currently called the *Tropical Agronomy Research and Higher Education Centre, CATIE*. The school originally was called the Interamerican Institute for Cooperation in Agriculture (IICA). Subsequently it was divided in two: a more policy-oriented institute, which kept the name IICA and the CATIE, which would focus on agricultural sciences. Other reasons mentioned for its establishment in Costa Rica were the relative proximity to the United States and the timely lobbying efforts by the Costa Rican coffee export sector (Martinez, 1931). The influential banana companies were also interested in studies for diversification of production for its disease infected plantations at the time (Cerdas, 1993).

Just as in other parts of Latin America, Costa Rican state formation was strongly influenced by intellectuals and technocrats adhering to a modernisation agenda (Robertson, 1984; Hopenhayn, 1992; Centeno & Silva, 1997). In 1945 a group of intellectuals and technocrats created the social democrat-PLN party[4]. The party gained influence because of its successful role in the short civil war in 1948 that started after the contestation of presidential election results[5]. The war is often mentioned as the reference point in history that marked the creation of "the second republic", with its new constitution. This constitution gave more room for state led development, with the nationalisation of banks, the electricity company, the abolition of the army and ways to stimulate the creation of an independent state bureaucracy. It also gave women voting rights. Since 1953 the social democrat PLN party became the major political force in the country, giving the technocrats a large role in state development. They guaranteed a social policy, upon which their power and legitimacy depended, but suppressed organised labour and forbade the communist party (Rivera & Güendell, 1989; Barrantes, 1986). The party also stimulated industrialisation of a predominantly agricultural country[6] (Dunkerly, 1988). Because of the top-down nature of the state organisation, the PLN version of democracy is often characterised as developmentalist but non-participatory (Rojas, 1989). This developmentalist strategy contributed to the economic success (Bulmer-Thomas, 1989:365), although in the eighties and nineties its excesses[7] were often criticised for inefficiency and a high state deficit.

[4] The "Social Democrat Party" originated from "The Centre for the Study of National Problems", consisting of Keynesian economists like Rodrigo Facio (Dunkerly, 1988:604), engineers that had studies abroad and wanted to bring progress to the country, and political thinkers like Figueres, who was part of the Caribbean Legion, a group of Latin American exiles that wanted to overthrow oligarchic dictatorships in Venezuela, Cuba, the Dominican Republic and Nicaragua. The 'Centre' was anti-imperialist, but less aggressive against national capitalists. Many of the founding members were also part of the national elite (Dunkerly, 1988:128 & 157). Later in 1951 the new name the National Liberation Party (PLN) was chosen for the alliance build around this social democrat initiative (Wilson, 1998).

[5] The explanations of the reasons behind this ‘revolution’ are still very much debated. In our view, it is most plausible to assume that the war had more to do with the struggle for state power, than with a class struggle, or with a clash of economic powers (Lehouque, 1991; Aguilar, 1973; Rojas, 1979; Schifter, 1979). The abolishment of the army was therefore a move to protect the new groups in power, since the military elites still had links to the old power block (Lehouque, 1991). This confirms Mouzelis' hypothesis (1994) that to understand the Latin state we have to understand 'the means of political control'.

[6]This idea can be seen in opposition to the thesis that industrial capitalists were pushing the state reforms that were implemented often against the traditional agro-export elites. Dunkerly shows that with a total absence of an industrial elite, it was the group around the PLN that managed to push through reforms for e.g. industrial stimulation.

[7] The excesses of state involvement were criticised even within the PLN party, because of potential (and actual) corruption. State funds were used for contracts or investments in companies belonging to those in government (or their friends) (Dunkerly, 1988:621-625). Also investments did not go hand in hand with higher tax revenues (Bulmer-Thomas, 1989). Relative to the other Central American countries, however, state funds were still used efficiently (-and not for blatant self-enrichment like e.g. in Nicaragua (Weelock, 1990) -). Investments in the social system contributed to international debts, but also generated legitimacy and stability, while the rest of Central America was collapsing into civil war.

The PLN-party originally saw the growth of the state system as a way of 'modernising' Costa Rica. The Costa Rican state has grown especially by the creation of 'Autonomous Institutions'. The new constitution of 1948 mentions three reasons to promote these Autonomous Institutions: 1) they would weaken the executive branch by giving political power to technocratic agencies, 2) it would give technical experts the mandate to promote development 3) they were intended to protect the welfare function of the state from retrenchment by unfriendly governments (Wilson, 1998:56). The autonomous institutions thus reduced the power of the presidency, which was already quite weak according to the constitution. The constitution also gave ministers in the cabinet an important position, and divided law making between the legislative and executive branch.

The way in which the election system was organised after 1948 has favoured two party dominance (Wilson, 1998). With its majority in the legislative assembly, the PLN party was able to push through the laws creating the majority of the autonomous institutions (Wilson, 1998). For this reason new institutions were seen as 'PLN-institutions'. This was complimented by the fact that the majority of the growing bureaucracy was partisan of the PLN party (which promoted and protected their existence). The state (with its development philosophy) therefore was often perceived (to a large extent) as a PLN entity (Rivera & Güendell, 1989; Murillo, 1986; Dunkerly, 1988).

By the seventies, the autonomous institutions were forces to be reckoned with. Tasks that before had been the responsibility of the municipalities, or had not been done at all[8], had become the responsibility of newly created institutes (Rivera, 1995). This process of transferring responsibilities implied that the state system developed as a very centralised (although compartmentalised) system. Not only was the decision power top-down, also spatially power was concentrated in the bureaucracy of ministries and autonomous institutes in the capital city (Rivera, 1995). The economic importance of the Central Valley for its prime export product -coffee - also contributed to this concentration of political power (Hall, 1984). All Costa Rican major cities are located in the Central Valley, which gave home to half of the population by 2001.

The idea of autonomous institutions was originally to limit presidential power. In the 1970s, after 20 years of political domination, however, the PLN wanted to get a better grip on the state bureaucracy. "More and more institutes are doing some form of planning of partial problems, in an insufficient way, without central directives and without coordination of the

[8] With this process of state formation the power of the multinational banana and mining companies was reduced. In the first half of the 20th century these companies were often the only authority in many isolated regions outside of the Central Valley. After the first attempt to 'nationalise' these rural areas through the creation of municipalities, the more powerful autonomous institutes formed a bigger challenge to the unregulated rule of the companies (Cerdas, 1993).

diverging and overlapping actions..." (Nuhn, 1972:32). With a majority in the Legislative Assembly, the PLN passed measures to centralise state power towards the executive. The Directors of the autonomous institutes would be appointed directly by the President, and the institutes had to create executive boards with 4 members named by the executive and 3 by the major opposition party (Wilson, 1998). Finally, the Presidential Planning Office would become the coordinator of all autonomous institutes (Wilson, 1998). According to the PLN party, planning would only work through a concentration of control in the executive branch over the bureaucracy of the Autonomous State Institutes. Resistance to these ideas was widespread and debates surrounding control and steering of technocratic independent institutes were fierce. Even in the late nineties, these discussions on the division of power between the executive and the state bureaucracy had not disappeared from the political agenda.

Table 3.2 Election Results (number of seats)[9]
(After Rojas, 1989; Wilson, 1998; Dunkerly 1988)

Year	PLN-Presidency	PLN	Main Opposition	Others
1953	*	30	12	3
1958		20	21	4
1962	*	29	27	2
1966		29	26	2
1970	*	32	22	3
1974	*	27	16	14
1978		25	27	5
1982	*	33	18	6
1986	*	29	25	3
1990		25	29	3
1994	*	28	25	4
1998		23	27	7

The discussion on state reform became more heated with the debt crisis in the late seventies and early eighties. The entrepreneurial sector and conservatives were more and more opposed to the state-led strategies from the seventies, and successive PLN governments were accused of widespread corruption. Opponents also saw increased state intervention as the main cause of the growing foreign debts. A coalition of liberals, conservatives and left wing critics of the former PLN governments, led by a dissenting former member of the social democrat PLN party, Carazo, won the elections, just as the worst economic crisis hit the country[10]. The new government (Carazo:1978-1982) tried to reduce the state bureaucracy,

[9]During the elections of 1966, the PLN still had a majority in the legislative assembly, but did not win the presidency. In 1953 a split in the PLN party caused the loss of the presidency, but later the renegade group (4 seats) joined the PLN in the assembly giving the PLN again a majority (Dunkerly, 1988). In 1974, the PLN won the elections from a divided opposition.

[10] The combination of low coffee prices, high oil prices, together with the breakdown of Central American Common Market (due to armed conflict in three member countries) caused a collapse of the national economy.

but the divided coalition could not pass its proposals in the legislative assembly (Wilson, 1998). In 1981 Costa Rica became the first country to default on its foreign debt and Carazo sent home an IMF (International Monetary Fund) delegation (Bulmer Thomas, 1989:325), making further negotiations for international assistance difficult (Dunkerly, 1988; Wilson, 1998; Honey, 1994).

It were subsequent PLN-governments of Monge (1982-1986) and Arias (1986-1990) that started with the first two structural adjustment programs aimed at reforming the state[11]. Structural adjustment was implemented following a strict neo-liberal policy. Costa Rican geo-political importance for the USA, however, enabled the PLN to follow a rather slow adjustment, with 'a human face'. Costa Rica received generous support from the USA in exchange for Costa Rican support for the "Contra"-war against Nicaragua. Hostile relations between the USA and Costa Rica's neighbour, Nicaragua, became an important negotiation factor in USA-Costa Rican relations. Costa Rica was portrayed by the USA as an ideological example of peace, democracy and stability, which had to be protected by large inputs of donor-aid, thus softening impact of reforms demanded by the IMF (Edelman, 1999). Of the total US assistance, the amount of donations increased while the loan component phased out to zero by the second half of the eighties. The advantage of giving donations (managed by USAID) instead of loans was that the latter would have to be approved by the Costa Rican legislative assembly[12]. With the donations, USAID had full freedom to assign the funds where they considered it would be best spent. This was mainly through the private sector and in NGOs (Honey, 1994) [13]. USAID funds were generously used to establish private organisations duplicating the tasks of the public sector, like e.g., new banks, a private export promotion company, private universities, agricultural services and a road construction company (Honey, 1994). This 'parallel state' weakened state institutions, and legitimated the neo-liberal project, by establishing showcases to "demonstrate the efficiency of the private sector initiative and the validity of the conservative version of 'civil society'"(Edelman, 1999:78). Without finance, and with competition from a heavily sponsored 'private' sector, the autonomous institutes previously involved in planning

[11] By this time the debt problem had become recognised as a world wide problem. As a result the IMF and World Bank tried to help Costa Rica in an attempt to prevent other countries to follow the Costa Rican example (Barry, 1989). The idea of a blanket boycott of paying the interest payments was seriously discussed in Latin America and certainly would have led to a collapse of the international financial system.

[12] In the National Assembly there was widespread discussion of slowing down or sometimes preventing reforms. This made the US ambassador Curtin Winsor bemoan in 1992 that "...due to their democratic and therefore inefficient government they had been unable to put together that [stabilization] program..." (Blachman and Hellman (1986) quoted in: Dunkerly, 1988:637).

[13] Most of the USAID money was channelled through a private office for export promotion (CINDE). This office was involved with lobbying on behalf of the private sector in the government and law making (Honey, 1999). CINDE was e.g. involved in stimulating the private forestry sector (Silva, 1997) and became an active participant in the development of Joint Implementation projects in Costa Rica (see chapter 4).

and the delivery services to the public were now weakened. Although there were no radical changes in the number of state institutes what did happen was a change in the nature of state intervention from direct involvement in productive activities and banking towards direct financing of social expenses and compensation (Sojo, 1992; Sojo, 1991).

Box 3.1 Generous US Assistance

At first conditionality was strict and as a small country Costa Rica had little negotiation power[1]. The international financial organisations pressured as a block to privatise state services, and reduce the state bureaucracy (Edelman, 1999). Although the PLN heavily resisted a government proposal to privatise the banking system, the international financial organisations forced the country to swallow 'the medicine' threatening to withdraw altogether (Honey, 1994) [1]. Later, conditions became more favourable and in 1984 and 1985 the amount of assistance accounted for an average of 35 % of the government's budget, and, up to the late eighties, Costa Rica was the second highest per capita recipient of US aid in the world (Sojo, 1991; Dunkerly, 1988:636). As a presidential candidate, Arias declared in 1985 that ,"as long as there are nine 'commandantes' in Nicaragua, we'll get $200 million a year from Washington" (Dunkerly, 1988; 640).

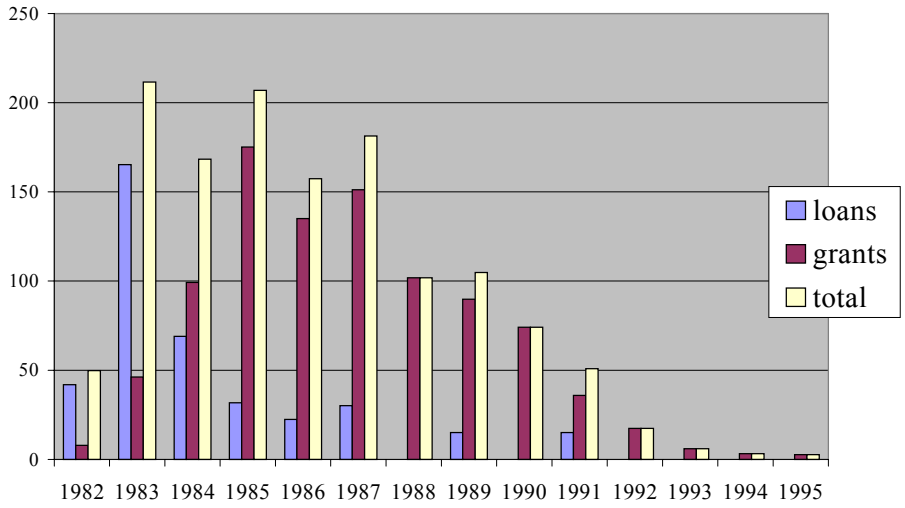


Figure 3.2 US Loans and Grants through time (From: Edelman (1999) pp76-77, table 5: Source: embassy USA, Costa Rica)

By the end of the eighties, two subsequent 'social democrat' PLN governments successfully stabilised the crisis through the promotion of exports and privatisation of state activities. Although Costa Rica was in a better position to repay debt, this was still a big burden on the national budget (Edelman, 1999). Foreign debt was almost as high as in 1982 and its servicing took up 30% of the state revenue. State spending had not declined and state reform, which on paper was aimed at a more efficient interventionist state, was in practice difficult to implement (Franco & Sojo, 1992; Rivera, 1995). With the discussions on state reform the 'PLN development philosophy' had changed from one of a strongly centrally planned state to one of a more regulative and efficient state, with more room for decentralised and (regulated)

market-oriented strategies for development. Throughout the eighties the state bureaucracy, although under attack, kept a central role in state affairs, with strategic tasks like energy, water and telephone services still firmly in the hands of autonomous institutions.

In the nineties, however, the Costa Rica faced a more difficult situation. After the signing of the peace throughout Central America, and the election victory of the US-supported opposition in Nicaragua, Costa Rica could not count on continued generous support. The state deficit remained a burden. Development aid in general was now channelled to newly democratising - and poorer - neighbours (Sojo, 1999:240). The PLN lost the 1990 elections because of its unpopular agricultural policies, internal divisions in the party and the unity of the opposition (the Social Christian Unity Party) with the son of the charismatic and popular president Calderon of the early forties running as their candidate. The Calderon (jr.) government (1990-1994) followed a more neo-liberal program and signed new agreements with the IMF containing stipulations about complete liberalisation of exchange and interest rates.

The Calderon government also started negotiating the third Structural Adjustment Loan, which contained more harsh measures including privatisation of state services and decentralisation of many tasks of the central state institutions (Rivera, 1995:172) [14]. The discussion about the new structural adjustment program in the National Assembly was very heated. The state bureaucracy opposed the measures, as did many members of Calderon's own party. Also the new presidential social democrat PLN-candidate for the next elections, Figueres (jr.), disapproved of the harsh conditions. Once Figueres was elected in 1994, he faced problems when the World Bank withdrew its loan, because of the budget deficit and the government's failure to reach agreement with the IMF (Edelman, 1999). The Figueres government had to change its policy, abandon the populist promises it had made during the election campaign, and follow the strict prescriptions of the IMF. Because part of the social democrat (PLN) party disapproved of the new IMF conditions, Figueres had secretly negotiated a pact with the opposition party to support the privatisation measures. This, together with secret negotiations to privatise the 'national pride', the National Electricity and Telephone Company, caused indignation, and led to several strikes, and the most forceful popular uprising since the early eighties (*La Nación, 17 April 1995*).

[14] According to the Calderon government, state reform meant "...making it smaller and more efficient (so that it will give better services). It is necessary to reduce the fiscal deficit ...and therefore ... do something about the most important part of the spending: salaries and the related costs. We have to deepen the transfer of public servants to the private sector" (Vargas, 1991, quoted in Rivera, 1995:167). For this purpose the government started a program of 'labour mobility'. This program, supported by a grant from USAID, gave state workers the chance to leave their jobs in exchange for a three-year salary payment and a guarantee to build up benefits. Between 8000 and 13,000 people left the state bureaucracy (Sojo, 1995:44).

Box 3.2 Reductions in the Agricultural Sector Bureaucracy

The state bureaucracy had severe reservations about the 'state reform', because the reductions in personnel and shifting competencies between institutions and departments could mean a loss of power and influence or also simply their jobs. Personnel felt that the reductions were more based on fiscal reasons than on reasons of reducing overlap and efficiency (Pomareda, 1998). Afterwards the 'Contralor General de la Republica' (Director of the National Administrative Control Office), Vargas denounced that during reforms too often qualified personnel left the state bureaucracy (la Nación, 17-09-2001). During the first years (1990-1994) the protests were not very loud, especially because of the 'labour mobility' program of the Calderon government, financed by USAID. The program gave generous rewards to people leaving the state bureaucracy, and resulted in a reduction of sectoral staff with 1101 positions, representing 18% of the total workforce at that time (Sojo, 1995). Protests were fierce during the first year of the Figueres government, when the threat to close the Land Reform Institute (amongst other state institutions) triggered a general strike. Although after hard negotiations the Institute was not closed down, it still lost part of its workforce (La Nación, 20-04-95, 27-04-95). The National Marketing Board that was especially hard hit by the reductions although it could transfer part of its personnel to privatised storage and marketing facilities. In total almost half of the workforce was sent home (table 3.3). After the first year of harsh reductions the first Minister of Agriculture resigned. The Minister was changed again in 1996, leading to continuing unrest in the sector (from 1986 to 1996 there were 6 ministers of agriculture, while the following government (1998- 2002) also had three.

Table 3.4 Personnel in Sectoral Institutes (Number of persons)

	May 1994	December 1997
Ministry of Agriculture	1854	1162
Marketing Board	1774	636
Land Reform Institute	809	476
Total	4437	2274

Source: Pomareda (1998:29)

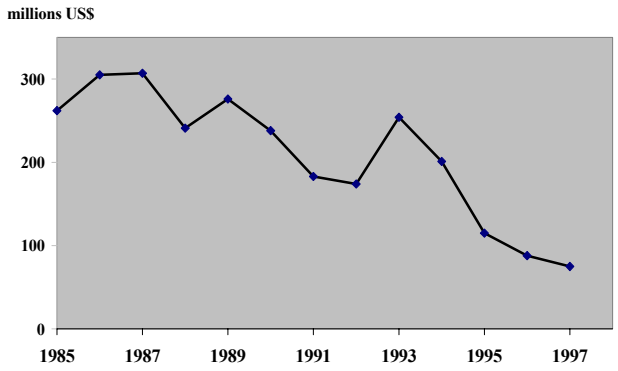


Figure 3.3 Sectoral Budget in real US$ (own estimations from Pomareda (1998) and Raine (1994))

Because the Figueres government was forced by the international financial organisations to deal with the debt crisis and follow a strict neo-liberal program we can still consider the change in the government as of little importance on the overall development strategy of privatisation and reduced state intervention. In the case study chapters we will see, however, that there was a marked difference between the Calderon and the Figueres administrations. In important land-use planning projects implemented during the Figueres government we can

recognise a policy that departed from a strict neo-liberal program. These projects were inspired and led by older technocratic PLN members. To attract money they promoted a model of regulated intervention and green business. While the government proposed privatisation, the state bureaucracy reinvented itself, by using planning ideas rooted in earlier decades described above (Table 3.1). This section has outlined the important changes in the Costa Rican state. The dynamics of state development described above are among the complex factors that led to different planning strategies as developed in different ministries and sectors, to which we will turn below.

3.2 The History of Land Use Planning

In this section I will summarise the development and change of land use planning and regulation by the Costa Rican state throughout three decades. In every decade there was a certain dominant conceptual planning 'model'. State planning was dynamically changing, however, because of continuous changes in discussions and ideas on planning as influenced by the wider intellectual discussions, national and international relations, projects and pressures, and changes in national politics. In the case of Costa Rica, these changes can be grouped into three periods: 1970-1978; 1978-1990; and 1990-1998[15]. The discussion on planning uses 1970 as a departure point. I use this year, because it was a turning point in state's attitude towards planning. In that year the PLN government put land-use planning high on the agenda, and proposed new forms of organising the sectoral and intersectoral interventions under the responsibility of a new Planning Office.

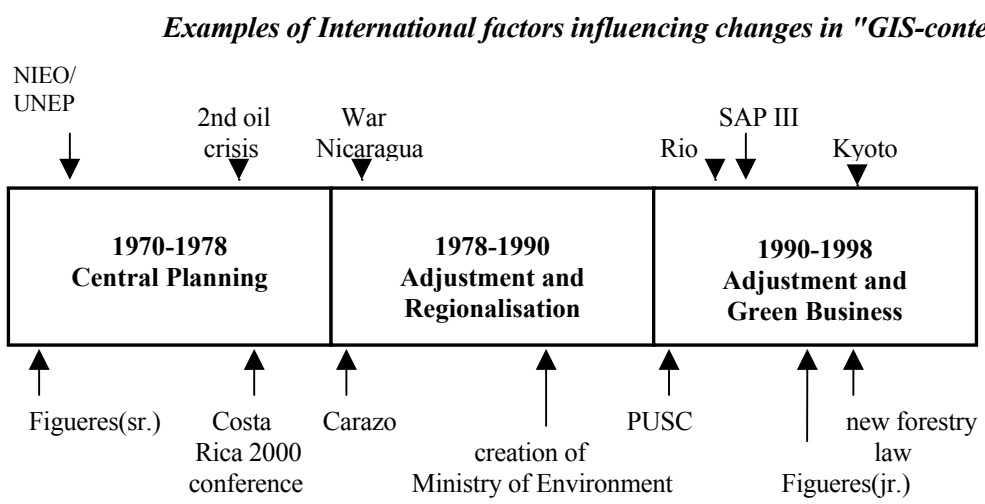


Figure 3.4 The dynamics of the Costa Rican planning models

[15] This periodisation is based on historical subdivisions similar to those used by Camacho (1993), Rivera & Güendell (1989) Morales (1989) and Rodriguez (1993).

In the remainder of this chapter I will first describe the international and national factors influencing the planning model in each period. Subsequently I will give an overview of the dynamics in the planning landscape and the changes in organisation of e.g. sectoral/intersectoral planning, central/decentralised planning and the steering mechanisms employed. The discussion of every period concludes with the consequences of these changes for the institutional organisation of information production.

3.2.1 The golden years of state planning; 1970-1978

In the seventies the international intellectual climate, and a planning-oriented social democrat government, led to 'scientific' land-use planning models, aiming at stimulating 'balanced regional development' and attention to industry and services. The Costa Rican government proposed to coordinate planning centrally under a technocratic presidential ministry, supported by one large central information institute. Resistance from various sectors, and the influence of important pressure groups, eventually stymied the creation of a central presidential information office. The agricultural sector remained central to regional development efforts.

National & international factors influencing land use planning

In the seventies there were three dominant factors that influenced overall discussions and organisation of land use planning. These factors will be described below in the following order: 1) the international belief in planning and its financial backing, 2) pressure groups in favour and against planning initiatives and 3) growing environmental awareness.

1) Internationally, planning was perceived as an important task for nation states, which was reflected in many initiatives and projects by international organisations and donors in Third World countries. Costa Rica was no exception.[16] Costa Rica's Planning Office was created in 1963. The first 'four-year' National Development Plans were made in 1963 and 1968. These plans remained 'paper exercises' and were not implemented due to changes of the government administration and lack of resources (Nuhn, 1972). This changed when the development-oriented PLN party came to power in the seventies, at the same time that there was a large supply of cheap international credit[17].

[16] The international support for planning began after the Punta del Este conference in 1961 that called upon Latin American countries to create 'Planning Offices' to channel the new development aid from the Alliance for Progress. This US-sponsored program was intended to create 'democratic and peaceful examples of development' in opposition to the Cuban revolutionary road (Rivera, 1987).

[17] The enormous surplus of 'oil-dollars' from the first oil crisis during the early seventies, and the success of the OPEC countries, created a large stock of capital that had to be invested somewhere. Latin American industrialisation was seen as a promising investment (Dunkerly, 1988).

The successful control over markets for natural resources by the oil producing countries of the OPEC inspired international discussions on a New International Economic Order, in which "...Third World Countries have now better negotiation power against the colonialist exploitation of its natural resources" (Dengo, 1977:545)[18]. In Latin America the Economic Centre for Latin America (ECLA) stimulated initiatives for regional 'endogenous' development and industrialisation, like the Central American Common Market, following new theories of (in)dependency (e.g. Kahl, 1976; Frank, 1971). In Costa Rica these discussions were translated by the Planning Office, focusing not only on economic development, but also on regional development, to stimulate the inclusion of poor and undeveloped areas in the creation of national wealth[19].

One important step taken by the PLN government was the creation of a corporation (CODESA) to function as a holding company and development bank. CODESA became especially important after 1974, giving out credits and investing in areas where private capital was not (yet) interested. It also stimulated investments in industry in poorer regions (Dunkerly, 1988). Many interest groups tried to benefit from these funds, but gradually protests started when it became clear that investments would only go to 'the lucky few' business partners of large state monopolies (Edelman, 1999).

2) The national pressure groups are an important factor in understanding planning dynamics. Apart from new pressure groups around industrialisation projects, the Costa Rican agricultural sector was still an important force influencing many decisions on land-use planning. Industry was not the only sector receiving support, and in fact many industrial investments were related to the powerful agricultural sector. Agriculture itself was supported with research, crop insurance programs and credit schemes (MAG, 1970; 1977). Especially the large land owning cattle breeders received vast amounts of credit. These elites had very good contacts in the government and the assembly, or were even members of it (Aguilar & Solis, 1988). Together with the old coffee elite, the cattle sector ensured that land-use planning projects were especially focused to benefit the agricultural sector. The support for cattle breeders during these years did not reflect the ‘rational planning models’ proposed by

[18] Jorge Manuel Dengo, former head of the Presidential Planning Office and founding father of the nationalized Electricity Company expressed these ideas at an important national conference in 1976. In his speech he emphasised the role of the state in natural resource exploitation and environmental issues. His position was that although foreign investments are necessary for development, these investments should be regulated by a pro-active policy, they should stimulate the labour market and involve national co-investments

[19] In an interview with Dengo (November 1997) he expressed his doubts about the 'economical boys from Chili' [ECLA], because no economic model could be considered good enough to describe reality. He promoted 'regional development' which included biophysical, economical, social and infrastructural aspects. This included ‘a vision’ of the influence of each region on the rest of the country.

the planning technocrats, because it caused the deforestation of large areas into extensive grazing lands[20].

An increasingly important pressure group was the state bureaucracy. In the seventies, it had become an important power factor in Costa Rican politics. In 1978 the number of people employed by the state amounted to 130,000, nearly 19% of the economically active population, and recipient of 28 % of national income (Dunkerly, 1988:605).[21] The number of autonomous institutes grew from 19 in 1970 to 27 in 1978. These institutes employed almost half of the total state employees (Murillo, 1986). The state was the most important employer of technicians and university graduates. The growing state also caused rapid urbanisation and drew many people looking for job opportunities to the Central Valley. (Rivera & Güendell, 1989). This caused a growing demand for municipal services and planned urban growth.

3) International environmental discussions in the seventies also had large influence on the Costa Rican planning landscape. Internationally there was also a growing consciousness of environmental issues. After the 1972 United Nations Conference on the Human Environment in Stockholm, Third World countries thought that they could form strategic alliances to get a better price for their natural resources, which now were considered to be limited. At the same time, the international concerns for the environment stimulated the creation of the United Nations Environmental Program (UNEP). Other international organisations like FAO (Food and Agriculture Organization of the United Nations) also called for more environmentally conscious decisions and interventions with the help of 'rational planning' and land evaluation (FAO, 1976).

The environmental movement in Costa Rica consisted mainly of educated professionals and students. These groups protested in 1970 against the establishment of the multinational ALCOA aluminium factory, an oil pipeline and road construction (Bonilla, 1983, Camacho 1993, Fournier, 1989). The Costa Rican environmental academics were (partly) successful in their protest because they had good international contacts. Most successful, however, was the Costa Rican lobby to protect National Parks. The international contacts ran through the CATIE (the international Tropical Agronomy Research and Higher Education Centre) but also through the influential Tropical Science Centre and the Organisation for Tropical Studies, founded by scientists from the USA. Also organisations like IUCN and FAO were

[20]The contrast between extensive cattle production and intensification efforts in other crops was very big. Coffee production per hectare became the highest world wide, and dramatic improvements were made in rice and sugar and vegetables (Aguilar & Solis, 1988).

[21] Although the growth of the public sector was much higher in Costa Rica than in the rest of Central America the expense could be sustained without high levels of either taxation or deficit financing because of the substantially higher levels of GDP in Costa Rica. It was only after 1975 and the second oil crisis that the economic problems began (Dunkerly, 1988).

very active in Costa Rica (Fournier, 1989; Rodriguez, 1993; Plath & van der Sluis, 1964). Beside helping the Costa Rican lobby in favour of forestry and conservation, these contacts helped to establish the international networks through which Costa Rica was presented as a natural paradise and an example in conservation (Wallace, 1992). The influence of the movement would grow, as we will see in the subsequent periods of the eighties and the nineties.

Model of land use planning

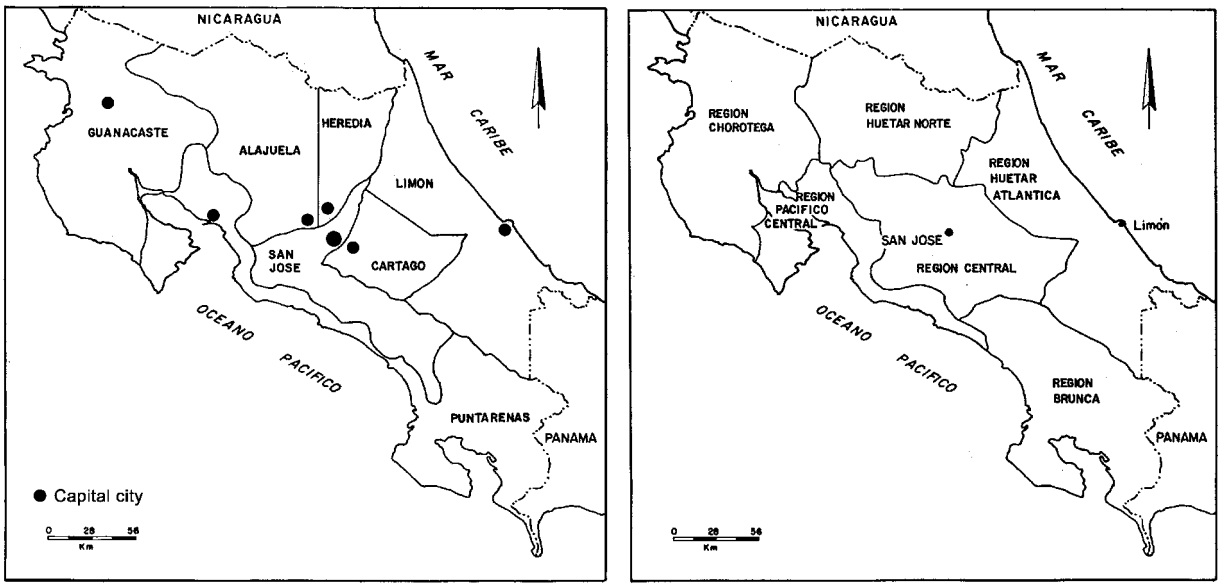
How did these three factors influence the planning landscape of the seventies? In Costa Rica, the international discussion on planning was translated into a complex reorganisation of territorial and sectoral planning. Subsequent governments therefore established a new Office for Planning, responsible for the re-organisations. The overall belief in planning and science was reflected in the top-down models proposed during this period. This caused, on the one hand, suspicion on the part of the sectoral bureaucracy, which did not want to give up its responsibilities. On the other hand, the private sector reacted to the new interventions by opposing some policies but also by using state resources for its own purposes. Models of land-use planning can thus be understood as a result of a complex interplay of planning intentions and reactions by different actors.

Government interventions were based on centralised top-down planning models and several projects. Planning efforts were aiming at regional or territorial planning, coordinated by a centralised planning office (or as proposed, a ministry). Territorial planning would take place on three levels (Nuhn, 1972); 1) the new office or ministry would be responsible for making interdisciplinary, inter-sectoral and urban development plans for every region, responding to national development goals, 2) sectoral institutes (in a new office or ministry) would make sectoral plans following the stipulations of the national plan and 3) the municipal governments would make regulatory plans in their districts following national plans, and with assistance from the regionalised state ministries and institutes.

Before the seventies regional planning consisted of rural development projects dominated by the agricultural sector (e.g. Plath; 1968; Nuhn, 1972). In the seventies planning was aiming to stimulate investments in depressed regions and prevent migration from rural areas to the capital (Nuhn, 1989; Morales, 1989). Although a lot of emphasis was put on the diversification of agricultural exports (Hall, 1984; MAG, 1970; MAG, 1977) investments were also made in other sectors, such as tourism, services and industry (Vargas, 1997).

Because, in the new planning model, all Ministries and sectoral autonomous institutes would have to work together, there was a need for standard homogenous intervention areas. The new Planning Office proposed a 'scientific system' of regionalisation based on concepts of rural cities as service centres. The provincial division of Costa Rica was seen as obsolete. It

was created through historical fights between the important cities in the Central Valley, which had divided the country as a pie, with in each piece a major city (Map 3.1) [22]. The government conducted several studies, of which the most widely accepted, by Nuhn (1978), used computer assisted factor-analysis of bio-physical, infrastructural and census data (Morales, 1975). The resulting map derived from this study divided the country in five rural homogenous regions, each with at least one 'central location' as a service centre. Beside these five regions a separate region was created for the Central Valley, which, with its high levels of urbanisation had its own specific problematic (Map 3.1).



Map 3.1 Provincial (a.) and Administrative (b.) Division of Costa Rica

The Planning Office opened several decentralised offices, to coordinate planning per region. In practice sectoral planning stayed very much top-down - depending on the ministerial stipulations - and only some administrative tasks were decentralised (Badilla, 1987). The sectoral state institutes were partly unwilling to decentralise activities, and partly faced difficulties in giving up their own regional structure (Ling et al, 1989). The resistance showed a tension between centralist technocrats (of the government) and a sectoral bureaucracy unwilling to lose control. The one sector that was relatively advanced in its regionalised interventions was the agricultural sector (Ureña, 1989). In regional planning practice the Agricultural Sector Planning Office[23] and the Presidential Office for Planning

[22] Besides being an electoral territorial sub-division, this provincial map was highly inappropriate for planning purposes (Soto, et al., 1980).

[23] The Agricultural Sector Office was an independent technical institute that had stimulated land-use planning and crop zoning since the late sixties, following the potential of each region (ibid.; MAG, 1970; Plath, 1968).

often cooperated on elaboration of studies and new projects, exemplifying the dominance of this sector in territorial planning[24].

The PLN governments (1970-1978) tried to help the rural poor by stimulating intensification and production through cooperatives, but also in mediating in land conflicts (Roman & Rivera, 1990). To influence the price of land they proposed a more effective land tax system to counter speculation and to limit the size of land holdings. The proposed law contained the possibility to expropriate land, to be redistributed among landless farmers (Barahona, 1980). These reforms were backed by international organisations such as the ILO (International Labour Organisation) and FAO which argued that small scale household agriculture would lead to much more efficient land use in production per hectare and person, as well as higher employment (CEPAL/FAO/OIT, 1973). This regulation of land use and national planning was resisted especially by the powerful agro-export elites, who prevented the passing of the land reform law, with its restrictions on land holding size and tax proposals (Barahona, 1980).

In the second half of the seventies, the state became directly involved in forestry planning. The state saw this resource as strategic for the public good. Under the influence of the growing concern for the environment, and with heightened interest in forests as an economic activity, the Ministry of Agriculture, through its Forestry Directorate, created several Forest Reserves. These reserves served to protect watersheds and develop a profitable state forestry sector. Finally, both PLN governments (1970-1974 and 1974-1978) established most of Costa Rica's National Parks (García & Ortiz, 1991). These were already presented as a way of attracting tourists, predicting the eco-tourism boom of the late eighties. Without strong pressure groups to resist direct state involvement in this sector, the Costa Rican state became an important proponent of environmental and forest issues.

Consequences for the institutional organisation of information production

With the growing importance of planning in 1970, information production became a central concern for the Costa Rican state. As opposed to most other Latin American countries, where the military had been responsible for map making, in Costa Rica the responsibility was given to the National Geographical Institute in the Ministry of Public Works and Transport[25]. This reflected the developmentalist attitude of the state and its governments, as

[24] In the seventies, they were successful with intensification programs for high potential coffee areas, while they promoted crop diversification in areas of low productivity for coffee (Hall, 1976). The zoning studies also were used by the National Crop Insurance Institute for selectively financing and insuring rice and sugar production (MAG, 1977).

[25] Since its foundation Costa Rica's Geographical Institute (IGN) worked closely with the "Army Map Service" of the USA, which gave technical assistance and financial support for topographical mapping throughout Latin America (Barrantes, 1975). Until the 1960s, topographical mapping was important for the construction of the Inter-American highway (from the USA to Panama). This project was seen as strategically important by the USA for the

described in the first section of this chapter (3.1). At the time, the strategic National Geographical Institute was perceived to be of central importance for overall investments in roads, electricity and water systems. As the National Geographical Institute was officially responsible for the production of all geographical information, the land registry, and maps, this institute became of strategic importance for the new planning efforts. The location of the institute became part of the discussions about responsibility over coordination of planning[26].

The government emphasised that for any sovereign nation it was important to collect centrally all the information on Natural Resources produced by national agencies and international agencies, 'which usually limit themselves by only handing over the legal minimum' (Dengo, 1977). "It is notorious how the industrialised countries have strong interests in making inventories of the world". To keep sovereign control over its resources it was important that Costa Rica would develop systematic and intensive overviews of the national patrimony, as well as a proper land registry (Dengo, 1977:545).

In line with its ideas about central planning, and its model of intersectoral coordination, the PLN government (1974-1978) presented a proposal to congress to make an Institute for Geography and Natural Resources (INDERENA) as a central information institute (OFIPLAN, 1977; Hartshorne, et al., 1982). Besides research, the functions of INDERENA would be: to set the norms for the use of the non renewable resources (mining), to manage and plan the rational use of the renewable resources (soils, forests, water and hydro-electricity) and to be responsible for nature conservation and environmental quality (Castillo, 1977; Rojas, 1977). By combining the dispersed information collection activities of the separate sectoral offices the government wanted to create a strong and central information centre (Nuhn, 1972). With these changes the government aimed to gain central control over the sectoral state bureaucracy, through the strategic position of this information institute, close to the president. It also showed how the government wanted to approach intersectoral planning of the regions, combining information on natural resources, land registry and census.

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defence by land of the Panama Canal, which explains the choice of some expensive stretches through mountainous areas, out of reach of enemy fire from the sea (Serrano, 1976). Also in the eighties the US National Imagery and Mapping Agency financed a project for the aerial photography of Costa Rica's Northern Zone, bordering Sandinista Nicaragua. The project was aimed at the modernisation of existing maps. In 1997 the Costa Rican National Geographical Institute was highly surprised when visitors from the USA mapping agency 'gave' a pile of CDs with the digital map of Costa Rica, with data from 1989, while Costa Rica already had been struggling since 1992 with the digitisation of its topographical maps (Bedoya, 1997). Apparently, the US already had these maps ready for an eventual direct conflict with the Sandinistas, preparing its "red light readable" maps, "to be destroyed when no longer needed" (DMA, 1989).

[26] Before its location in the Ministry of Public Works and Transport, suggestions were made to transfer the Geographical Institute to the National Registry, and become a Department for Land Registry and Topography. In 1970 the Institute had for a short time been part of the Ministry of the Presidency, while subsequently it was proposed to transfer the institute to the National Presidential Planning Office and become the National Institute for Geography and Natural Resources (Barrantes, 1975).

The discussions in Congress around this proposal raised awareness of environmental problems, but in the end the creation of INDERENA was not approved (Hartshorne, et al., 1982)[27]. Questions were raised about the political willingness of the different separate sectoral Ministries to support INDERENA (Boza, 1977) and the willingness of sectoral institutes to transfer personnel for inter-sectoral and regional planning (Nuhn, 1978). To curb protests from sectoral ministries, where it was argued that this would give the president too much influence, plans were made to ensure that the institute would become autonomous and 'neutral' and deliver the information for the National Planning Office and Sectoral Planning of the Ministries (OFIPLAN, 1976) [28]. At the same time, however, other government proposals continued to put these institutes under presidential control (see section 3.1). For this reason the controversy surrounding how to establish a 'neutral' information institute remained a running battle.

The original proposal suggested that INDERENA should be part of a new Ministry of Planning or Planning Office. Information and regulation on Natural Resources was presented as being important for all sectors. But not everyone agreed with this view. Earlier proposals suggested that INDERENA should be part of the agricultural sector, because the Ministry of Agriculture was responsible for forestry issues, land use potential and rural development (OFIPLAN, 1976). The environmental movement on the other hand was in favour of making new Ministry for Natural Resources, defending the natural resources against the stronger agricultural and economistic development efforts (Mata, 1977; Boza, 1977). They thought that such a new Ministry should have far-reaching powers and 'its decisions would be binding' (Boza, 1977:613). Finally, most agreed that municipalities should contribute to local planning through regulatory plans by zoning the rural, industrial and urban areas. The more market-oriented people, however, thought that no central planning would be necessary at all, and wanted to combine municipal zoning with selective taxes and a transparent land market (Rodriguez, 1979; Chaverri, 1997). They were, therefore, not against INDERENA or

[27] Although the INDERENA didn't become a reality, USAID financed extensive studies and training for agricultural zoning and the use of new methodologies of remote sensing for land use planning purposes in the late 70s. The project proposal document explicitly mentions the goal of becoming part of a future INDERENA (OFIPLAN, 1976). The interdisciplinary research was carried out by professionals of the National Geographical Institute, the Ministry of Agriculture (including foresters), and the National Housing Institute. After the proposal for INDERENA had been rejected in Congress, in the final report of the project, the USAID consultants proposed to make a National Information System in the National Geographical Institute, because it is already the coordinator of many studies and has legal responsibility for the production and distribution of maps (Sader, et al., 1979:146-7).

[28] The National Plan created by the Oduber administration (1974 - 1978) explained the plans for INDERENA; it would be responsible for all the tasks formerly done by the National Geographical Institute (topographical mapping and cadastre) and the 'dispersed' research efforts of different ministries and public institutes. Priority would be given to 'studies on water, hydrocarbons and mining' (Government of Costa Rica (1974) quoted in:Barrantes 1975:52). Studies of natural resources done by INDERENA would help with " correct national territorial planning, and … stimulate development" (OFIPLAN, 1976:10).

information production as such, but did not want it to be part of a planning institute, or to have regulatory powers. They favoured the Institute becoming part of a National Registry (Barrantes, 1975).

These discussions reflected the positions and influence of different pressure groups on state organisation. While centralist technocrats of the government wanted an interdisciplinary information institute, the environmental movement proposed a separate coordinating role for 'natural resource' issues by a new 'green' institute, while agriculturalists saw the agricultural sector as independent and central to all rural issues. Finally a private (rural and industrial) lobby favoured non-intervention and the promotion of a small institute to guarantee a transparent land market. As we will see later, these discussions will come back in each of the three case studies.

3.2.2 Regionalisation, the Environment and Adjustment with a Human Face 1978-1990

To deal with the debt crisis of the eighties the Costa Rican intervention model changed from state led development to a more neo-liberal model of development planning, which aimed to stimulate efficiently organised export production. Because of international pressure and lobbying from an influential environmental sector, new participatory and market-oriented planning models were adopted in the environmental sector. This led to tensions between the NGOs and private sector on the one hand and the bureaucracy on the other, over the destiny of state funds used for private initiatives and responsibilities for regulations. International and national attention to 'sustainable development' also led to a discussion over the definition of 'the environment' as an intersectoral issue or as sectoral issue. By the late 1980s the Costa Rican government proposed to create a central information office to coordinate intersectoral responsibilities.

National and international factors in crisis management

The main factors in the period from 1978-1990 are described below. These were: 1) the oil crisis and the structural adjustment programs, triggering a new export oriented development strategy, 2) the rural protests as well as lobbying by the agricultural sector, 3) the new international and national discussions on sustainable development.

1) The main factor that led to a crisis in state-led development and central land-use planning was the economic crisis of the late 1970s. The international financial system proposed Structural Adjustment Programs as a 'cure' for the bankrupt industrialisation and import substitution strategies of the seventies. The Structural Adjustment Programs were based on a neo-liberal model of running the economy. As described in the first section of this chapter (3.1) Costa Rican adjustment was not as 'harsh' as in many other parts of the world, because of the generous assistance of the USA. This gave successive governments room for manoeuvre to evolve their intervention models.

2) A second factor influencing the way in which planning models changed was pressure from protesting farmers and the renewed confidence of a powerful agricultural lobby. With the structural adjustment policy the latter group gained in importance, because agricultural exports were presented as a solution to an ailing economy.

According to the new development logic in the 1980s food production in Costa Rica was inefficient and small farmers were to produce more profitable export products. Credits, subsidies and price controls in national basic grain production were abolished. The government prevented major upheaval by slowing down price liberalisation, by compensation measures, and through rural projects for so called 'new exports' by small farmers (Edelman, 1999; Roman, 1994b). The government was able to keep legitimacy because these compensation measures were made possible through the financial support of the USA. Still, many farmers went out of business (Honey, 1994; Roman, 1997a).

A large part of the international aid was used for the stimulation of new (and old) agricultural export production. Most of the government subsidies for the stimulation of exports went to the old agricultural elite (especially producers of bananas), and investors in 'new' exports, including large multinational companies[29] (Franco & Sojo, 1992). The result was a relatively successful development of pineapple, fresh flowers and ornamental plants, roots and tubers and fruit exports. In the long run, however, the subsidies for export promotion would form a heavy burden on the state budget. The proposal to abolish these subsidies (as also demanded by the IMF and World Bank) was boycotted in the National Assembly, illustrating the continuing influence of the agricultural elite in the Costa Rican bureaucracy and politics (Edelman, 1999) [30].

Not all the traditional agricultural elite benefited from structural adjustment programs. Because of unfavourable liberalised market conditions the cattle sector ran into problems of paying back loans. In 1986 the government settled the loans, but while originally funds were meant only for small farmers, finally also large farmers were included and this turned out to be a most costly undertaking (Lutz & Daly, 1991; Raine, 1994)[31]. Environmentalist claimed

[29] Around ten percent of the $72 million distributed in 1988 and 1989 went to PINDECO, the pineapple subsidiary of Del Monte, while half of the total amount went to only 26 companies (Edelman, 1999). The total of national exporters received around 44%. Companies with both national and foreign capital received 32% (Franco & Sojo, 1992:73).

[30] Often 'he sector decided to put forward an influential person as 'their' minister. The Ministers of Agriculture were therefore often part of the landed elite, or agribusiness sector (Franco & Sojo, 1992).

[31] Large cattle farmers able until the 1980s to obtain cheap credits for land purchases and clearing of their properties were facing unfavourable market conditions ((Aguilar & Solis, 1988). By 1986 nearly two thirds of Costa Rican bank loans for cattle were in arrears and cattle ranchers began to pressure for relief. With the passage of the FODEA-law most loans were settled, providing ranchers with an annual subsidy of $16 million dollars in 1988 and 1989 (Kaimowitz, 1995; Lutz and Daly, 1991).

this subsidy was rewarding and promoting the practice of transforming forests into pasture lands. The environmentalists were becoming more influential because of the growing international pressure to promote 'sustainable development'. Even though the cattle sector was saved from bankruptcy, the eighties marked a change in the governments' attitude towards this extensive and inefficient sub-sector.

3) The discussion on sustainable development was the third important factor influencing planning models. It had an important impact in Costa Rican politics. This was caused by the growing influence of environmental pressure groups and the growing importance of eco-tourism for the economy (Vargas, 1997). The World Commission on Environment and Development, created in 1983, tried to resolve tension between the new goals of market-led development and the environment. This new solution was termed 'sustainable development' (Adams, 1990). At the heart of this concept was the assumption that growth and free markets could prevent poverty and because poverty creates environmental destruction, (properly guided) sustainable development would also lead to less environmental destruction (WCED, 1986). The international discussions led many donors to put the environment on the agenda[32].

USAID used their donations to promote a specific, more neo-liberal, model of regulating land use. Environmentalists in Costa Rica supported this 'model'. Frustrated with the earlier lack of state funds for conservation and forestry efforts many in the environmentalist movement were open to the proposals of the USAID for more public-private partnerships (Wallace, 1992). They felt they had to 'guard nature from ignorant farmers', but also from 'a corrupt state bureaucracy' (Camacho, 1993:205, 219). During the eighties, given generous international support, these environmental groups gained in importance. They managed to play a considerable role in institutional development and law making (Camacho, 1993).

The Arias government (1986-1990) put natural resources high on the agenda, raising it to the level of other economic sectors. After one month the new administration created the Ministry of Natural Resources and Mining, aiming at "the stewardship of Costa Rica's natural assets, including parks, reserves, watersheds, hydroelectric generating capacity and … hydrocarbons and minerals" (Umaña & Brandon, 1992:89). Because of the financial crisis one of the main challenges for the new Ministry of Natural Resources was "to develop a new financing mechanism so that objectives could be met without the drainage of scarce economic resources" (Umaña & Brandon, 1992:89). The strategy was to involve the environmental movement, through NGO partnerships, in the generation and management of

[32] Environmentalist pressure caused the donors to take up environmental concerns. USAID was one of the first to change its policy after a congressional hearing in the late seventies about its programs' impact (Kaimowitz, 1993).

funds for nature conservation.[33] Through the 'debt for nature swaps' the Ministry received US $43,000,000 to be invested in the conservation areas, in partnership with environmentalist NGOs (Mahony, 1992). [34] After 1987, the amount of money invested by these NGOs surpassed the state expenditures in the sector by roughly $2 million a year (García & Ortiz, 1991:45). Debt-for-nature swaps showed the growing influence of donors on national policies, and stimulated more private and NGO involvement in protected areas.

Large investments through these NGOs had an impact on the Ministry's functioning. It opened up room for new experiments in public-private regulation of protected areas, but also undermined attempts to create a strong new ministry. NGO-partnerships faced growing resistance from public employees, because loss of decision power over donor money, unclear competencies, better wages and unstable job perspectives (García, 1993; Rodriguez, 1993). In contrast to the well-paid NGO job market, the structural adjustments caused instability in the state bureaucracy. The way in which the structural adjustment programs were implemented, and the way in which environmentalism was used in state reform and new experiments in public-NGO partnerships had a large impact on the land-use planning models and projects of the eighties

Land use planning models 1978-1990

Structural adjustment, pressure groups and a burgeoning environmental movement had specific influence on planning models. The structural adjustment programs resulted in little money for development of regional planning research, programs and projects. Together with the privatisation of the state banking system, the government lost an important instrument for guiding investment. (Inter)sectoral and regional planning became far less important than macro-economic planning[35]. What had been the Planning Office during the seventies was changed into a Ministry of Planning, after 1981. The new Ministry was vulnerable and weak from the start.

[33] The privatisation experiments started with the lucrative activities of conservation like tourism and biodiversity, while more difficult activities, like policing parks, forest permits and conflict resolution, stayed within the realm of the public sector (Camacho, 1993).

[34] The Debt-Swap idea is based on the idea that because a country is not to be expected to be able to pay back its debts, that the debt is sold to third parties for a reduced value, which will be invested in the local economy. It means that the state is changing its international debt into a reduced national debt. The debt for nature swaps did little to reduce the debt burden, and in fact increased the value of the Costa Rican remaining debts. It also forced the Costa Rican State to invest in nature protection, although it lost control over its spending. The debt for nature swaps were left because of the poor results for the debt burden, but also because of detrimental effects on inflation and loss of control over state finance.

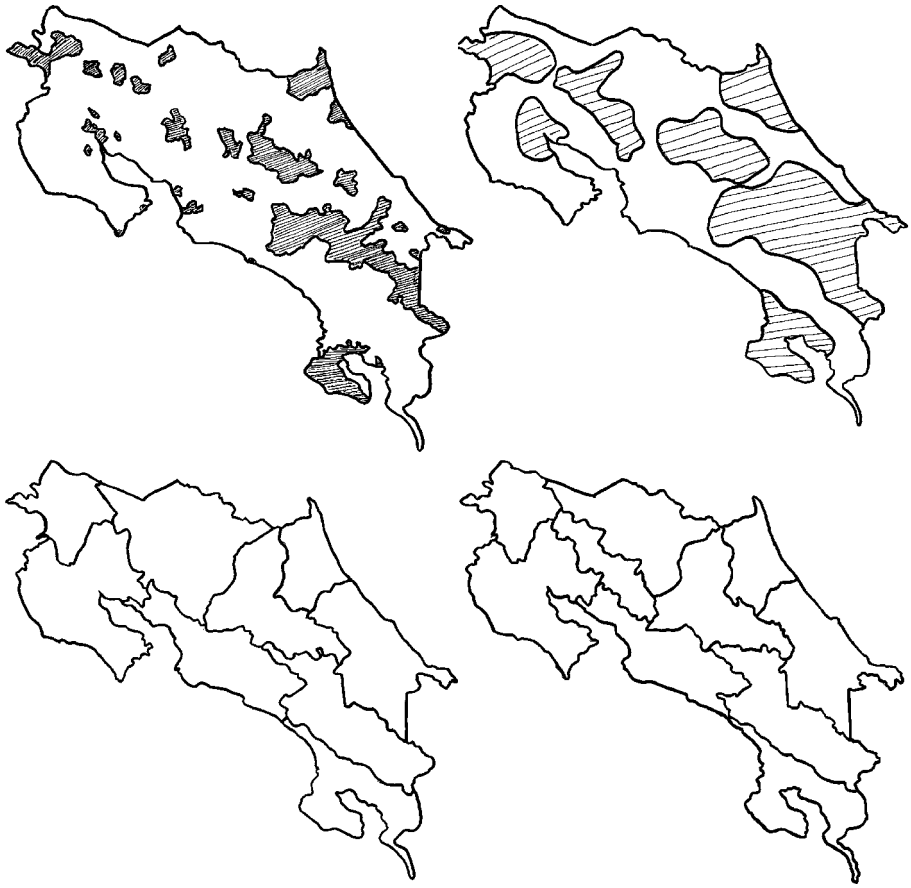
[35] Because of the dominance of macro-economic criteria in the thinking of the Arias government the Minister of Agriculture Dessanti left the Ministry in 1988 (Roman, 1994b).

In the governments' plans regional planning still was an important means to counter the economic crisis, in that it would deliver state services more efficiently, while participation would give the government more legitimacy. In practice most attention was paid to guaranteeing legitimacy. This was reflected well in the reactions of the subsequent governments to rural unrest. Morales (1989) describes this as a 'fire-man-strategy' use of regional planning because resources were invested especially in areas with land conflicts, tensions and high poverty (see also: de Vries, 1990). This meant that 'regional planing' was often not more than a list of projects (Camacho, 1993; Badilla, 1987; Kruseman, 1990). This reactive strategy made it difficult to make any real regional planning possible.

Box 3.3 Regional Planning Practice in the 1980s
The new Ministry of Planning stimulated participation of municipalities in the 'Regional Councils', to be guided by the coordinating Regional Offices of the Ministry [1]. These offices also would advise the President of the Republic on regional development strategies and elaborate studies and 'Master Plans' for the regions (Kruseman, 1990). Most regional 'Master-plans', however, were not more than lists of projects[1]. The plans generated some funding, important given the decreasing ability of the state system to pay for its own projects (Kruseman, 1990; Morales, 1989). The idea of the councils was also to create proactive planning strategies. Most of the projects were formulated in response to the economic crisis and rural unrest (Morales, 1989; Camacho, 1993; Mora, 1989). The Regional Councils finally faced problems in finding cooperative donors. Donors preferred to work in separate independent project teams, and did not coordinate with the Regional Councils. USAID, the European Community and others ended up working predominantly in large Integrated Rural Development projects with one state institute or ministry, outside the councils' control

Environmentalists protested the absence of any 'planning' approach concerning the government's agricultural polices and projects. Supported by USAID, environmentalists proposed to limit state intervention using a new 'objective' land use capability classification (CCT, 1985). The method classified land into only a few categories of agricultural, pasture or forest land (CCT, 1985). In 1987 the system was made official by presidential decree. It was hoped that it would be a way of guiding all state interventions, and would prevent land degradation and limit spread of grassland. In practice, however, the method was used in discussions about the division of responsibilities of the Forestry Directorate, the Park System and the Ministry of Agriculture. This became most cynically obvious during a conflict on the deforestation of primary forests for banana plantations. Because the area had a land capability 'I', for 'agricultural use' the agricultural sector claimed to improve land use (Lutz & Daly, 1991). The capability system was certainly not threatening export production on high quality lands. Against the will of the forestry department, permits had to be certified because the 'official method' had been followed. Although planning models and the capacity system were intended for proactive policy making, they often served as legitimation after the fact.

Regional planning became more complicated when the Arias government (1986-1990) made a new Ministry of Natural Resources, with a new administrative regional division for the forest and park areas. It divided the country into 'Conservation Areas' comprising national parks and buffer zones around them. These new units would be managed in a decentralised manner, under NGO leadership, more or less independently from the former central and regional planning schemes[36] (Camacho, 1993). Other sectors were unhappy with the growth of the influence of the new Ministry of Natural Resources. In the previous period the Ministry of Planning (MIDEPLAN) was defined as the location for coordination of regional planning. The Ministry of Planning saw the new Ministry of Natural Resource as a threat to its coordinating tasks. First, the Ministry of Planning was not happy with the new administrative division of the Ministry of Natural Resources. "The Ministry felt that the [conservation areas system] instituted a regional process that bypassed MIDEPLAN's administrative and planning division " (Umaña & Brandon, 1992:95). According to the Minister of Natural Resources, he 'successfully argued' that 'what we did was not planning but implementing' (ibid.). This did not end MIDEPLAN's suspicions.



Map 3.2 Changing Concepts of Conservation Areas: Protected Areas (a.); Protected Areas with Bufferzones (b) in 1986; Back to only Protected Areas in 1991 (a); Two Versions of Extended Responsibility outside Protected Areas in 1996 (c); and 1998 (d) (sources: Garcia & Ortiz, 1991; Bradley et al., 1989; www.sinac.go.cr).

[36] The Mining and Hydrocarbon departments kept the original centralised administration (Quesada & Solís, 1988; Chaves et al., 1995).

MIDEPLAN also criticised the involvement of consultants and NGOs in the operation of the new Natural Resource Ministry, as being costly in economic terms, but also in terms of loss of coordination and coherence within the state system (Ulloa, 1989 in: Camacho, 1993:242). In their view, by the involvement of NGOs in running the national territory, the state sold out its responsibility of coherent and efficient land use planning.

The conflict was partly resolved in a proposal made by the end of the eighties. The Strategy for Conservation and Sustainable Development (ECODES), offered a solution to the conflict between MIDEPLAN and the Ministry of Natural Resources This reflected a solution offered earlier (in the seventies) when the creation of a central Information Institute (INDERENA) was discussed. Most important in the new proposal was a coordination 'system' for planning. The ECODES-strategy identified three key tasks for the state to stimulate sustainable development; 1) *ordenamiento territorial* (territorial zoning[37]), 2) integrated management of the natural resources and 3) the control of the environmental quality. The tasks of inter-sectoral coordination on these issues were divided between the Ministry of Planning and the Ministry of Natural Resources (Quesada & Solís 1988:311). These proposals, written in 1990, were only taken up again after 1994, with the Figueres' presidency attempting to stimulate intersectoral planning.

The Consequences for the institutional organisation of information production

The structural adjustments and the lack of clear planning strategies, as described above, had implications for organisation of information production. At the start of the eighties this was determined by the Assembly's decision nót to approve the creation of the Institute for Geography and Natural Resources (INDERENA).

Because the intersectoral institute was never created information production was organised along sectoral lines. Information projects in the agricultural sector improved the capacity of the sectoral office, which slowly was gaining independence and control over the production of thematic maps, thereby weakening the National Geographical Institute. The production of a new soil map, for example, was no longer the responsibility of the National Geographical Institute, but of the Agricultural Sector Office. It was presented in 1979, in a blaze of publicity as a step forwards towards efficient agricultural development.[38] The decisions clearly reflected the unpopularity of interdisciplinary planning and the importance of sectoral

[37] Ordenamiento Territorial is difficult to translate. A direct translation is "putting everything in the territory in its right place". It has elements of 'ordering' or 'classifying' in it (which can be in a done participatory way or not), without the connotations of traditional top-down planning. In essence it refers to regional zoning, planning and regulation. The term 'ordenamiento territorial' became fashionable in Latin America by the late eighties, to counter critiques of old planning models and to promote a role for the state in environmental planning matters.

[38] Alexis Vasquez, one of the central figures in soil science in Costa Rica (June 1996).

specialisation. The National Geographical Institute was then weakened further, in 1981, when the Carazo government separated the Land Registry from the institute and moved it to the National Registry. This decision showed that land ownership registration was perceived as an administrative issue important only for a functioning land market.

The stimulation of the agricultural export sector called for information to identify high-potential areas for certain crops. To find interesting areas for investments, the Agricultural Sector Office produced crop-zoning maps for promising crops. These studies were based on crop specific evaluation criteria, and used general 1:200,000 information. The maps were freely available and encouraged multinational companies and government agencies to start experiments on crops in specific areas.[39] With the change towards more neo-liberal policies, and the growing importance of the environmental movement, this information became criticised. The environmental movement thought that the scale was too general (1:200,000). This would not help farmers in individual decisions. The environmentalist also did not agree with content of the maps. These maps showed that areas with a 'low potential for crops' were classified automatically as 'grasslands'. Classes for forestry were totally absent (Tosi, 1991). This supported the movement's claims that the government strategies favoured cattle production, and were therefore 'too productivist'.

In place of general planning the environmentalists called for more effective field control measures for conservation and nature protection (Hartshorne, et al., 1982). The above mentioned capability system was defined as a 'field method for land classification', as an alternative to overall planning efforts. The implication of the method was also that no overall information gathering was necessary for decisions on permits, or subsidies, but that at the local level state officials should check if the land use was appropriate, following the method[40].

The discussions on territorial and sectoral responsibilities, described in the earlier section on planning models, showed the importance of how information was interpreted and the role of such interpretation in negotiations on institutional change. In 1990, such the discussions culminated a national Strategy for Conservation and Sustainable Development (ECODES). All sectors presented themselves as central information providers, with importance for other sectors (Quesada, 1990). The ECODES document proposed to create a shared central

[39] ministerial official (M50, august 1997).

[40] The capability system was not adopted without resistance. The Erosion Control Service had its own classification system (Tosi, 1991). It pointed out that classes would change when erosion measures were taken (FAO, 1996a; Tosi, 1991). They pointed out that individual crops have different requirements, so a homogenised category of forests or agriculture is too broad for different crops. For example, banana can grow on shallow soils, while the 'official classification' would immediately designate this as area for protection. A field method that would cure these weaknesses was impossible, because it would require too much detailed information on different crops and ecological situations.

database between the Ministry of Natural Resources and the Ministry of Planning, to service general intersectoral planning. To guide land-use planning, a special 'technical secretariat' would have 'at least access to one of the GIS of the country' (Quesada, 1990). GIS was presented as an answer to the dispersed nature of information production that had become organised along sectoral lines[41]. How GIS influenced actual information production and exchange in Costa Rica will be discussed in the next chapter. First we have to follow the historical description of planning models and their overall influence on institutional developments of information production in the nineties.

3.2.3 Markets, public-private partnerships and 'green business': 1990-1998

The 1990s break with the previous periods. While in the 1970s central planning was proposed as ‘a cure for all’, economic crisis in the 1980s forced the state towards more efficient intervention and experiments with participatory and market-based steering mechanisms. By the 1990s the government was faced with a continuing economic crisis, but now lacking support from the USA, so a strict neo-liberal adjustment program had to be followed. State intervention was further reduced and state institutions closed. This situation led to more room for participation and market mechanisms in planning, especially in the environmental sector. In the later half of the nineties, the Figueres government tried to stimulate a new role for the state as coordinator and regulator of private initiatives. Green business was encouraged, but following rules set by the nation state. With this new idea of (regulated) green business, geographical information became more and more important, especially as a means to create transparency and legitimacy in a growing new market.

National factors & international factors in 'the environmental decade'

In the nineties two factors were important for understanding changes in planning models: 1) the overriding sentiment that ‘the market’ and liberalism had triumphed as the model for development, 2) the United Nations Conference on Environment and Development (UNCED), which influenced both discussions on development and created hopes for money transfers from the North to the South.

1) With the election of the neo-liberal Calderon administration, the development model changed. The Calderon government believed that the PLN governments of the eighties had failed to deliver the deep reforms in the state budget, necessary for stability. The continuing crisis in state finances made that the neo-liberal paradigm would become accepted as a

[41] The IGN had some remnants of a GIS of the IADB project, which was not functioning (interview with sub-director Carlos Elizondo, 20-12-1995) and the UNA had developed a large project on GIS with the University of Ohio, with a wide variety of 1:200,000 topographical, natural resources and census data (Marble & Wilcox, 1989). The MAG was just starting the make a Natural Resource Database for the agricultural and forestry sector. Also in the aftermath of the hurricane Joan in 1989 the UNA, the infrastructural sector, and the National Emergency Committee proposed to form a national database with all relevant information on roads, waterways, electricity and city infrastructure (Salgado, 1996).

leading philosophy for both major parties during the nineties (*La Nación, 13 November 1996*). Subsequent governments decided, therefore to follow a strict neo-liberal policy, including privatisation and reducing state spending (see also 3.1). Internationally, 'planning' had become a 'dirty word', and according to the new philosophy, the state tasks would have to be limited to areas were markets does not function well: poverty reduction, infrastructure and environment[42]. The IMF and World Bank demanded decentralisation and/or privatisation of important state services to municipal levels (Rivera, 1995). Because the state was reduced in size, new ideas about steering had to be found. The new market philosophy and environmental projects stimulated discussions on deregulation, participation and market steering. International organisations, such as the FAO, earlier promoting top-down planning (Fresco et al., 1990), took up participation as their recommended intervention method (FAO, 1994). Within Costa Rica bureaucrats started to question old ways of doing things (see e.g., chapter 5). Alliances emerged between market thinkers (who were against state intervention), environmentalists and farmer movements (who were disappointed by an inefficient and sometimes corrupted state) during experimental planning projects on decentralisation and local intervention.

2) The second factor of importance was the UNCED conference itself. Together with many other developing countries, Costa Rica hoped the Earth Summit on Environment and Development in 1992, would lead to large transfers of money because '..of the fact that this is the environmental decade' (Boza, 1991; quoted in Rodriguez, 1993:110). The Latin American governments presented their view in "Our Own Agenda" (IADB-UNEP, 1990), promoting a vision of sustainable development with an important regulating role for the state. With its good international contacts and new experience with debt-for-nature swaps and public-private partnerships in conservation, Costa Rica was an attractive country for experimental environmental projects.[43] This gave the country access to donor funds for environmental projects. The Calderon administration signed a 'sustainable development treaty' with the Dutch government for 'reciprocal development'[44], and participated in experimental projects funded by the World Bank 'Global Environmental Facility'. The strategy culminated in the adoption of sustainable development as a main emphasis of the succeeding Figueres' government program in 1994.

[42] See Gomez (1994) for a translation of these ideas for Latin America.

[43] The Earth Summit was led by Maurice Strong, a former businessman from the hydro-electricity industry, with good contacts in the international business world. He stimulated participation of industry in the Earth Summit, and defended the private road to environmental protection (Kolk, 1996). Strong also had very good ties with Costa Rica. Before the summit, he already owned protected land in Costa Rica, and after the summit, as head of the Earth Council, he promoted the establishment of its headquarters in Costa Rica.

[44] In theory this would mean that both countries would help each other to reach 'sustainable development', through environmental studies, projects and comments. In practise, however, it was a way securing large inflows of money for the Costa Rican state and non-state agencies. The treaty caused an explosion of environmental NGOs, and also caused a change of NGO activities, from local activism to policy and law making (Mora, 1998).

Figueres' discourse on sustainable development emphasised the market benefits of the environment[45]. At various times the president stated that forest protection was 'big business' (Figueres, 1992; Mora, 1994), because of its links to hydro-electricity, biodiversity prospecting and possible markets for the sale of environmental services, notably 'clean air' to polluting industries (see chapter 6). The two factors that influenced this period were combined. The international intellectual climate promoting markets, together with attention for environmental issues were translated in Costa Rica into a strategy for attracting investments. Nowhere is this clearer than in the change of the name of the Ministry of Natural Resources to the Ministry of Environment and Energy, in 1995. This clearly reflected the new image that Costa Rica was seeking to project internationally. While at first the environmental movement was happy with the Figueres program for sustainable development it later became more and more critical. Limited government budgets and ongoing privatisation led on the one hand to government failures in reaching effective state mechanisms for regulation and on the other hand empowered logging companies and industrialists (Quesada, 2000).

Land use planning models 1990-1998

Calderon's neo-liberal strategy had enormous implications for the planning strategies of the different state institutes. The Calderon government closed all Regional Offices of the Ministry of Planning in 1991. In doing so, it abandoned regional intersectoral planning by the Ministry. The outflow of people from this Ministry continued after the change in government in 1994 (Rivera, 1995). Officially 'regionalisation' of interventions continued, but was now limited to sectoral specialisation and privatisation. To comply with strong pressure from the World Bank, Calderon also had various studies made of tasks that could be decentralised from Ministries and Autonomous institutes to the municipalities. Because of resistance of both the bureaucracy as well as the National Assembly, hardly any decentralisation measures were taken (Rivera, 1997).

Calderon saw a large role for the Ministry of Agriculture in 'regional planning', which was interpreted as rural planning. Agriculture would only be promoted in areas of high potential. Anti-erosion measures would be obligatory in more critical areas, and lands with 'forest' or 'conservation-capacity' would be regulated by the respective Forest and Conservation Departments of the new Ministry of Natural Resources.

With its emphasis on sectoral specialisation the Calderon government also changed the definitions of the intervention areas and sectoral responsibilities of the Ministry of Natural

[45] Part of the idea of Sustainable Development was also a strategy of promoting investments of the energy-demanding information technology. Figueres promoted the country as a new Silicon Valley, with cheap hydroelectric energy, an environmentally friendly image and a docile, but highly educated population (*la Nación 1/8/97* and www.cinde.co.cr, visited in April 1998).

Resources. In 1986, the then-Minister Alvaro Umaña proposed, to include ‘buffer zones’ as an area of influence around protected areas, as part of the intervention area. In 1990, the new vice-Minister Mario Boza was in favour of 'traditional conservation' of only the National Parks and Biological Reserves, without defining a buffer zone (Rodriguez, 1993; Camacho, 1993). While in 1986, the proposal was to unite the Forestry Directorate, the Directorate for Wildlife and the National Park Service in the Ministry, in 1990 these departments were kept separate, each having its own geographically defined protected areas (García, 1993). And while Umaña wanted to include environmental criteria in all sectors, Boza applied a more isolated sectoral approach to natural resources issues.

Not only the definitions of sectoral and territorial intervention changed. The Forest Directorate was stimulated to deregulate and enhance market instruments for good management (Chapter 6). In line with the overall market logic to development, the Calderon government (1990-1994) made new a proposal for legislation to create the 'National Conservation System'. This proposal explicitly implied private involvement in National Parks management, and proposed the transfer the benefits of these public areas to the people living around them (GOCR, 1993). Every Conservation Area was to get its own trust fund "..with the objective that its allocations do not enter into the state's funds, to avoid public-administration bureaucracies, and to handle the funds for the purposes for which they are requested..". National Parks and State Forestry Reserves were to be administered entirely by NGOs (Rodriguez, 1993:116). The law proposal was never approved.

With the new market ideology, however, contradictions in regulations emerged. The land-use capability system came under attack. Within the Ministry of Natural Resources, the system was seen as superfluous because state interventions should be limited to 'officially declared' protected areas only. In the Ministry of Agriculture the system was still promoted, and supported by the environmental movement, although in the Extension Service and Erosion Service protest was growing because of its technical shortcomings (Hoogenboom et al., 2000). The Erosion Service also argued that farmers had many reasons other than the 'soil capability' for making land-use decisions (FAO, 1994).

The new PLN-government tried to promote more intersectoral coordination, reflecting the proposals of the late eighties (Dengo, 1992). The PLN thought that one central institute should be responsible for a broad range of long-term studies and regulations concerning land use and protection, while at the same time it should promote decentralisation and balanced regional growth (Lücke, 1995; Dengo, 1998a). To implement these ideas it started a project for “Ordenamiento Territorial”, involving an office responsible for intersectoral coordination, environmental and land-use regulation. After four years of negotiating with the sectors, and adverse attitudes to planning, the project team gave up its attempts (Chapter 7).

The Figueres government (1994-1998) also changed the intervention areas of the Ministry of Natural Resources (later, Ministry of Environment and Energy). The Ministry would now be responsible for all environmental regulation in the country (also outside of protected areas). The spatial definition of 'conservation area' was therefore changed into a nation-wide division of the territory. In the new definition 'the conservation areas' contained all protected areas, but also the areas around them, dividing the whole country in 11 areas. Some aspects of environmental regulation would be transferred to the municipalities, assisted by the local offices of the Ministry, but major projects, conservation activities and environmental regulation would become the responsibility of the Central Office of the Ministry. The forestry department, the parks service and other conservation departments were fused into one administrative unit, the "Conservation Area". These changes showed Figueres' attempts to make environmental regulation an intersectoral issue, which was one of the few tasks left to the state in the neo-liberal era.

Even though the Figueres government (1994-1998) wanted some form of intersectoral coordination, in practice it promoted market mechanisms to regulate land use. During this period the forestry sector was deregulated to give room for private forestry business. With the 'market steering' forest use, the 'land use capacity system' became useless for territorial and institutional divisions. The idea of 'environmental services' was worked out during the Figueres government, of which the service of 'clean air' became world-famous through its promotion at the Kyoto conference on Climate Change in 1997, as a model establishing a market in "pollution rights" (Chapter 6). Forest use would be rewarded with 'carbon-payments'. The state was necessary to guarantee and certify the system as a whole and guard the quality of its products.

The Figueres administration promoted a new approach to local participatory planning in rural areas, emphasising the role of the private sector. After the failure to create a central intersectoral office, mentioned above, the agricultural planning bureaucracy reacted against the threats to its existence. In 1997 it reclaimed its central role in rural planning issues. In a compromise between the populists and the 'capacity system-adherents', the *Law on Land Use, Conservation and Management* was pushed through the Assembly guaranteeing the sectors' influence in many areas, such as, (participatory) planning of rural areas, defining and regulating the optimal land use for purposes of projects, government programs and 'regulation plans' of municipalities (Chapter 5). Through this new law the Ministry remained close to its 'old planning' ideas, in times of market dominance. The Ministry saved its central role because of the legal obligation of other actors to use its soil information and advice on (rural) land use.

The consequences for institutional organisation of information production

In times of rapid change in the role of state, and with the rise to prominence of more market-oriented steering mechanisms for land use, information proved to be of pivotal importance for the survival of several institutes. With the election of the Calderon government in 1990, the ECODES proposal to create an intersectoral information institute was abandoned. In line with its planning intentions, the Calderon government wanted information production to be organised by sectors. Given that the Calderon-government emphasised the land-use capacity system as an official method for sectoral planning and territorial divisions, the Structural Adjustment Project for the Agricultural Sector (PASA) was of strategic importance. It contained the elaboration of soils maps, and delimitation of all protected areas. The new soil map would enable the application of the land-use capacity system at more detailed and municipal levels. Although the project was not approved, in the heat of the 1994-elections, by the National Assembly, it formed the blue print for institutional reform of the sector. The production of soil maps, however (and their use for rural planning) was postponed until 1997. Only than, the ministry could claim back its position in regulation of land use, when the Figueres government failed to create an intersectoral planning office.

During the Calderon administration NGOs were most influential in environmental information production. They received large amounts of international donor support, in addition to 'debt-for-nature-swap' money from the previous period that still was being reimbursed in this period. To the frustration of the state bureaucracy, NGOs kept their information often as strategic assets to be sold to new projects, or to guarantee donor money. With a few exceptions[46], the information was dispersed and often lost after the end of the project.

The Figueres government took up the challenge from the ECODES-proposals and tried to stimulate intersectoral planning. It did so using a 'neutral' information project, to convince the sectoral bureaucracy that it would be interesting to cooperate. The information project also implied institutional reform. Originally, the project was intended to link the National Geographical Institute with the National Land Registry. It would become an information institute of the President or an office of the Ministry of Natural Resources. The project managed to collect existing digital data and produced a new digital topographical map of the country, but failed to push through the institutional reforms, and also failed to get the responsibility for all sectoral information production. This showed the power of the sectoral bureaucracy, but also the inability of the government to convince the National Assembly that some form of intersectoral regulation would be necessary.

[46] Especially the Tropical Science Centre and the Neotropical Foundation have nation wide data and maps that could be interesting for national planning purposes.

While originally this intersectoral information project also would be responsible for producing information for the monitoring of the new system of market oriented forestry, because of problems during the project and the urgency for information results that had to be presented at the Kyoto conference on Climate Change, the Minister of Environment and Energy decided to hire private consultants to make a national forest cover map. The design of the monitoring system, under the responsibility of the National Forestry Fund, which functions as a public-private hybrid, reflected this market approach. This Forestry Fund would become a key player in distributing environmental services and monitoring the information around the carbon subsidy-system.

Unlike the attempts of the PLN technocrats, between 1994-1998, to come to central intersectoral information production, information production stayed divided following sectoral lines. Information was not only a tool in straightforward planning processes but also was used in negotiations around institutional reform. This can be partly understood from the change in planning from direct intervention towards more regulating and coordinating tasks that the state has taken up to redefine its functions. Through the importance that coordination and regulation is assigned, information becomes a strategic asset indispensable for these tasks. Technology implementation can only be understood from this complex interplay of institutional reform, and survival of old ideas in recent times. How this happened, I will describe in detail in the case study chapters.

3.3 Summary & Conclusion

This chapter described a large part of the contextual background for the case studies. This was not an easy task, since the contextual background involved taking into consideration many levels of organisation, philosophies of planning and their translation into policies and projects. To break down this complexity, I have differentiated between the essential components of the Costa Rican planning landscape through an overview of 1) the political system and 2) the history of planning ideas, their translation into models and strategies, and finally, the influence this had on the organisation of information production. These changes are described across three decades along government shifts and political fault lines. Table 3.1 summarised this approach.

In the first section of this chapter we focussed on the political history of the context. We saw how the Costa Rican State developed with strong developmentalist and centralist tendencies. The state bureaucracy has been characterised as being powerful and relatively autonomous from the changing governments, although key positions in many state institutions were changed with every new election. The role of the dominant social democrat PLN-party was, at least up to the eighties, central in the development of a relatively successful social welfare state. Since the eighties, under pressure of the debt crisis, the successive governments have

been trying to reduce the state bureaucracy to make it more efficient (a strategy from the PLN party) or transfer more responsibilities to the private sector (a strategy from the conservative opposition party, PUSC). We have seen how the state bureaucracy reacted to these pressures by reinventing itself taking up new roles in e.g., planning and information production.

In this chapter we also reviewed the overall planning philosophy in Costa Rica along political fault lines and through time. Planning philosophies have been divided into three periods.

1) In the seventies there was a tendency for a strong involvement of the state in land use planning.
2) Due to the pressures of the debt crisis, the social democrat PLN changed its intervention strategy in the eighties. The new strategy entailed more regionalisation and more efficient coordination of planning issues, while experiments of public-private partnerships were possible in the nature conservation sector.
3) In the nineties, two sub-periods can be distinguished, although the overall planning philosophy was pursuing 'green business opportunities'. In the first period (1990-1994: under the conservative PUSC-party) more attention was paid to ‘sectoralisation’ and task specialisation of different ministries and institutions, while in the second period (1994-1998: under the social democrat PLN-party) the focus changed towards coordination efforts through intersectoral/environmental 'planning models'. In this last period more attention was paid to information as a strategic asset for the state to steer the development of the ‘green markets’. Changes in steering mechanisms and state reform were often fought out through projects of information production, and proposals to change the location where this information would be produced.

Having reflected on the overall planning philosophies, this chapter narrowed the focus to the context of specific developments in planning, its translation into models and the consequences this had for the institutional organisation of information production. This has demonstrated how policy was (-and sometimes was not-) put into practice. Throughout this chapter, we have seen how the organisation of information production over three decades was influenced by the changing demands from the planning models. In the seventies the government stimulated large intersectoral information projects and tried to create a central intersectoral information institute. In the eighties projects and planning were focused on agricultural (export) production. This went together with sectoralisation of information production. In the nineties information projects were aiming at more efficient state intervention and 'information services'. Because of the donor support for environmental issues most money went to environmental projects. With the change towards sectoralisation and reduction of the state system, information also became strategic as a new means of regulating land use and markets. In the upcoming chapters we will focus on case studies

featuring three ministries (the Ministry of Agriculture, the Ministry of Planning and the Ministry of Natural Resources). As will become evident, the historical context out of which those ministries were created will play an essential role in understanding the main discussions, actors and choices of GIS implementation.

The three ministries in the case studies were created and transformed at different moments in history. This contributed to how the different ministries developed distinct main focuses linked to the dominant planning ideas of a specific period. Firstly, the power dynamics around intersectoral planning were key in understanding GIS implementation in this Ministry of Planning. Its role in coordinating all land use planning grew out of the discussions in the 19070s. The planning philosophy of this ministry reflected these ideas of strong central executive control, and/or a strong central bureaucracy. With slight adaptations this role was restated in different forms in all three periods. Information was seen as key and should be controlled close to the central executive (the president). In the nineties, these ideas surfaced especially during the social democrat PLN-party government of 1994-1998. Secondly, the agricultural sector was historically important in Costa Rican rural development. Especially in the eighties the sector reclaimed a central role in the rural regions, when the development strategy was changed from a hesitant (industrial) import substitution strategy towards one focused on agricultural export production. The dominant 'planning model' in the Ministry of Agriculture in the nineties can be seen as a continuation of the ideas of ‘zoning’ and ‘high potential production’-areas that were developed fully in the eighties. In the 1990s, however, other ideas on planning were also promoted by the government. Different choices for GIS implementation in this Ministry will be related to discussions of planning within the sector, and in defence of the sector. Finally, the forestry and nature conservation sector slowly gained in influence through time. Distrustful of both the state and the productivist private sector the forestry and conservation sector developed more private, participatory and/or technocrat steering methods for land use change. The foundations of 'green business' ideas were applied for the first time in the eighties, with the debt-for-nature swaps, although their further development was realised only in the nineties, under strong neo-liberal pressures and in a new and growing Ministry of Natural Resources (later Ministry of Environment and Energy). The upcoming case featuring this ministry will illustrate the implementation of GIS under strong influence of ‘the green business model’ and with generous support from the donor community. Before turning to the cases, I will first focus on GIS technology in Costa Rica, and its influence on the production of information during the nineties.

4

GIS in Costa Rica

Introduction

In the historical overview of the previous chapter we saw how it was not until the 1990s that GIS began to play a role in Costa Rica. This chapter will describe the introduction of GIS under the contradictory pressures of, on the one hand, liberalisation, deregulation and state reduction, and on the other, renewed attention to environmental issues creating some room for manoeuvre for the proponents of land-use planning and state regulation.

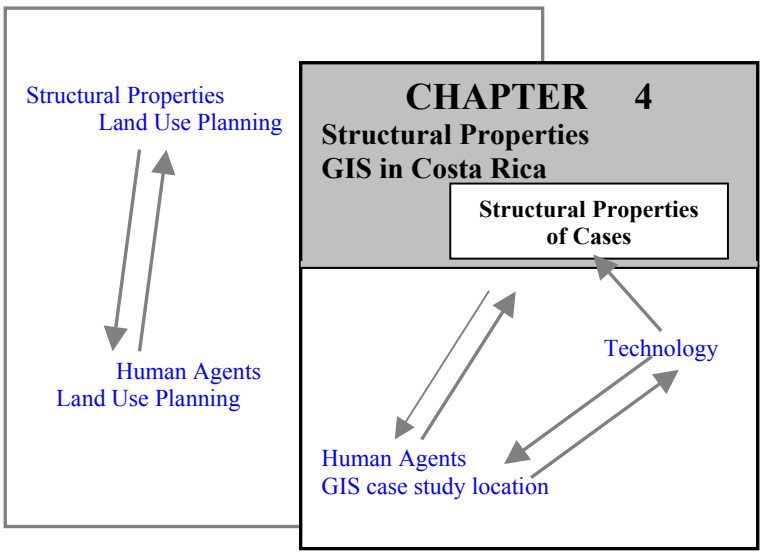


Figure 4.1 The Structural Properties of GIS Technology in Costa Rica

Whereas a 'mainstream' overview of GIS would focus on issues such as technological potential, quality problems, and the availability of hard and software, this chapter focuses on the relations between GIS implementation, GIS operators and organisational context. The material upon which the chapter is based consists of my research findings using a qualitative questionnaire with GIS professionals at 37 locations, and many additional interviews on GIS development. Combining these two information sources, my total inventory includes data on most GIS laboratories (51) in Costa Rica. In addition, I gained a careful insight from examination of 'grey' literature on GIS in Costa Rica (Junkov, 1993; Consultora Cuatro, 1994; Fallas, 1995; Rodriguez, 1996; Gonzalez, 1997; Aguilar, et al., 2000; CIAT, 2001). Based on these findings, the chapter will give an overview of GIS implementation, and the

GIS operators' perceptions, goals, and ways of dealing with problems. The inventory also includes the actual applications of GIS. Together, these descriptions of GIS implementation in Cost Rica give a good indication of the ways in which the Costa Rican 'GIS-community' handled problems of e.g., data exchange, training or legal problems. These descriptions therefore give an approximation of the institutionalisation of new norms (what is accepted behaviour in exchange processes), resources (who has the power, money and expertise to steer future developments) and accepted conventions on how to understand GIS and its products (what are accepted standards and uses).

This chapter is as an important component in the analysis of the (overall) structural properties of GIS implementation in the case studies (Figure 4.1). Because I will not describe individual organisations, the unique structural properties of the GIS departments within each of the case studies will not be dealt with in this present chapter. In this chapter, I begin with an overview of the important technical developments and main sectoral fields of GIS application (4.1). Secondly, in section 4.2, I will discuss motivations and problems, and contrast this with the actual products of GIS. Who was involved in its introduction and with what expectations was it introduced and used? In section 4.3, I will finally outline some of the consequences that GIS has had on the institutional culture of information production. How does GIS enable different human practices of information production and distribution and networking? The chapter concludes with a short summary of the findings (4.4).

4.1 An Overview of GIS in Costa Rica

Costa Rica was one of the first countries in Central America to implement and experiment with GIS. Through a description of the general aspects of implementation, investments, training and sectoral applications, this section (4.1) will give a general sketch of Costa Rican GIS-developments.

GIS implementation

Costa Rica has been always on top of international developments in the area of GIS and remote sensing. In the late 70s the country experimented with the use of remote sensing for land-use applications, through an USAID project (RDA, 1979). In the '80s the National Geographical Institute was the centre that promoted remote sensing, but because of discontinuation of project money, the Institute stopped investing in new computer applications until the early nineties[1]. The School for Geography of the National University (UNA) was the first to develop an operational GIS. A geographer, Leyw, who just had come back from Germany, started experimenting with simple GIS software applications in the first half of the eighties. In 1987 Leyw's department hosted the first Latin American Conference

[1]Sub-director of the National Geographical Institute (Elizondo, 27-08-1997)

on Informatics in Geography (Leyw, 1987). The department also started collaboration with the University of Ohio, which led to a large nation-wide GIS-database in the department.[2] Leyw himself went to the USA to work for the leading GIS software company, ESRI, as the sales representative for Latin America.[3] The 1990 'First Space Conference for the Americas' held in San José, Costa Rica, showed a continuing interest and involvement in developments of remote sensing technologies (IGN, 1997).

The "big boom" for GIS in Costa Rica started in the 1990's (Figure 4.1). Because of the technical knowledge necessary for using the first very crude GIS-software packages of the eighties, it is understandable that the first GIS applications were developed in the university centres. The need for powerful computers and complicated software prohibited the widespread use amongst planners and policy makers. The university GIS applications were mostly straightforward for the study of specific problems. Often academics had to adapt crude software to their own needs (Leyw, 1987). After the technology established itself among the university community, in the early 1990's, the government and NGOs followed.

Already by 1992 an overview study of the International Union for the Conservation of Nature (IUCN) mentioned that in comparison with Central America, Costa Rica had many computers and a high level of GIS training. Of the 7 institutions interviewed for this study, three were using digital data as the main form of data handling, while some data were exchanged in digital form (Junkov & Rovinski, 1993). Compared to the rest of Central America, and considering the small size of the country, Costa Rica with over 53 GIS locations in 1997, had developed as a pioneer in GIS development in the region[4].

> *During the Central American 'project for local human sustainable development' of the United Nations Development Program (UNDP), the differences between Costa Rica and the rest of Central America became clear. While in other Central American countries the project just started with the elaboration of national-level very general poverty maps, in Costa Rica, the local project director could start immediately with developing more advanced applications for local and regional decision making, because the technology*

[2]By the end of the 80s, the UNA-Ohio project had generated a large database with 35 coverages of 1:200,000 containing topographical data, census data and some biological data (Marble & Wilcox, 1989). The data was later used for training purposes (U50, 20-05-1998), but not many people knew of its existence. Many other organisations duplicated the digitisation of the topographical base map of 1:200,000, and a large project for a National Geographical Information Systems (TERRA), in 1997, imported the same database from the USA partner of the UNA, not knowing that the database was available in the country.

[3]GIS academic (U50, 25-05-1998)

[4]Compare e.g., Martin (2000), who mentioned that Ecuador had 20 organisations with a GIS in 1996, mostly financed by international donors like IADB, USAID and UNDP. These donors perceived Costa Rica as relatively advanced in GIS-data production and availability (interviews with several officials form international financial organisations: IFI4, 4-11-1997; IFI3, 18-08-1997; IFI1, 24-07-1997). By the late nineties, in other Central American countries GIS implementation was speeding up. El Salvador, for example, developed an interesting network of GIS users for producing and exchanging information in a more efficient manner (PROSIG, 2001; ASUSIG, 1998).

(telephones, electricity and computers), information availability and the administration system were more developed (PDHSL, 1997).

The boom of 'NGO GIS applications' (Figure 4.2) went together with the growth of funding of environmental projects around the United Nations Earth Summit in Rio de Janeiro in 1992, and the popularity of NGO involvement in Natural Resource Management in the Costa Rican Protected Area System (Chapter 3). In the state system, some large investments in ambitious GIS departments of the National Land Registry and the GIS for housing and Urban Planning stimulated, with a delay of a few years, a spin off for GIS use in municipal governments and other (autonomous) state institutes. Private sector applications started in the late 90s. After 1992, the number of government applications surpassed the university sector, and continue to this day.

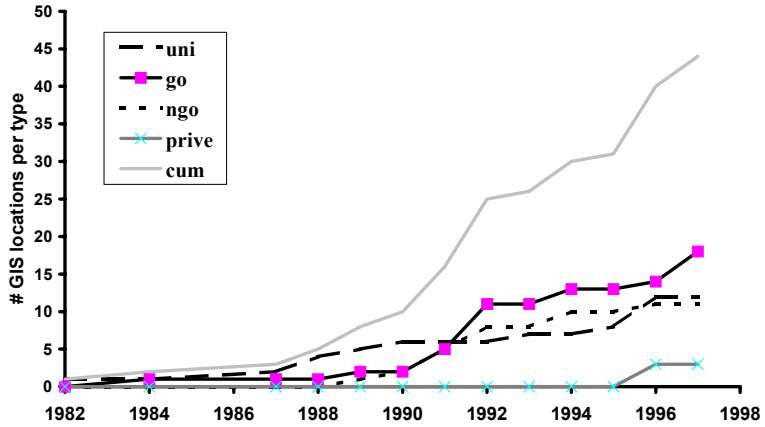


Figure 4.2 Growth of GIS installations in different organisational settings.

GIS investments

As already mentioned in chapter 2, there are many GIS applications and ways of organising it. The general distinction made by Clark (1998) between 'project GIS' and 'institutional or enterprise' GIS is useful to discuss developments in Costa Rica. The first category is GIS developed by its user (often only one person) for a specific problem or project, in which the data collected are used for the specific application. Generally, the 'GIS' consists of only one computer and software. University GIS developments are usually a typical example. The 'institutional GIS' are normally dealing with more routine and standard data handling for complex organisation and different users. Usually the end-user is only involved after the development of data sets and GIS application development. Implementation involves large powerful computer equipment and sometimes network building. In these projects, discussions on data definition and access to databases are often the most important focus of project implementation. Typical for this example are GIS of e.g., the Land Registry, Topographical Services, or state planning institutes.

Estimating the magnitude of investments in software and hardware[5], we see in Figure 4.3 that although 'project-GIS' outnumbered the 'institutional GIS', it was the limited number of 'institutional GIS' projects that took up most of the investment (although also smaller 'institutional GIS' exist). After 1998, investments continued and the popularity of GIS remained high[6].

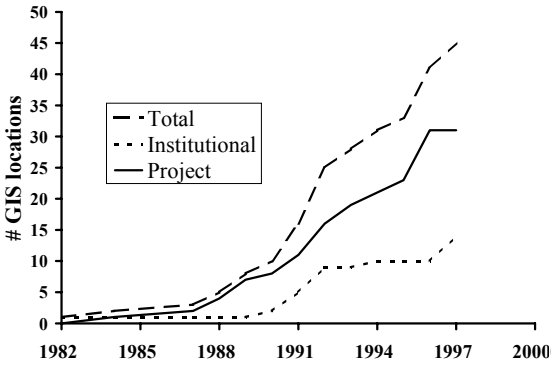


Figure 4.3a Growth of 'project GIS' and 'Institutional GIS'

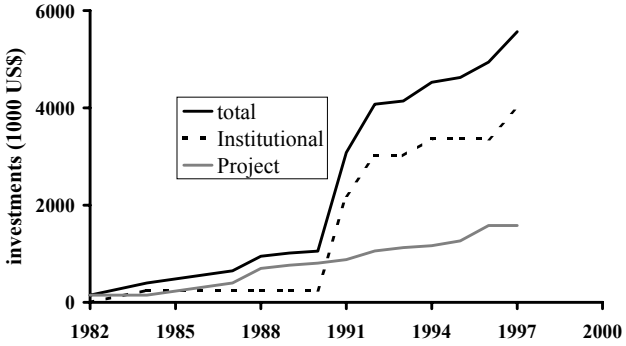


Figure 4.3b Growth of 'project GIS' and 'Institutional GIS' in Costa Rica

To understand the reason for the vast amounts of money invested in Costa Rican GIS, we need to look further than the 'project GIS'. We see that the 'institutional GIS' projects (such as, the Electricity and Telephone Company, the National Land Registry, the National Emergency Committee, a National GIS for the infrastructure sector, and a National GIS for national planning) were the most important. All these projects aimed in varying degrees to produce diverse data with a national coverage, for a variety of user groups. Apart from the specific case of the National Electricity and Telephone Company, the progress of the bigger national GIS implementations was slow and difficult. Some projects were perceived by the GIS community as highly unsatisfactory (Diaz, 1997b). It is interesting to note that the number of projects that began through local investment grew parallel to the large institutional GIS applications (mostly financed with donor money), suggesting a spin-off of the investments for practices elsewhere[7].

[5] The only documented estimates on investments in hardware and software in Costa Rica were made by Consultora Cuatro (1994) giving a figure of $5,600,000 for 11 big institutions in 1994. This does not included data-collection nor salaries and operation costs, which would multiply the amount three times (Christiansen, 1998).

[6] This included a sub-project for 'Ordenamiento Territorial', of the National Computer Networking System for Sustainable Development (SINADES). The 'ordenamiento territorial' project invested around US$ 3.5 million (RECOPE-MINAE, 1996; interview with bank official IFI2, 20-10-1997). After 1998, municipalities were stimulated to use GIS in land registry project (US$ 75 million) *(la Nación 18/02/2000*). In 2003, the Centre for High Technology (CENAT) invested 2 million US$ for multi-spectral images, for environmental purposes and topographical mapping (*La Nación*, *20-03-2003; 03-6-2003*).

[7] This indication was plausible because some early municipal GIS laboratories were stimulated to use GIS-data from the Land Registry, while the GIS for Housing and Urban Planning signed cooperation-contracts with municipalities and other state institutions from the infrastructure sector, to encourage GIS implementation in these organisations.

Large 'project GIS' investments were made in the Tropical Agronomy Research and Education Centre (CATIE) and the National Universities' TELESIG-Laboratory. While universities often were at the forefront of technology application, supported by foreign donor money,[8] most other 'project GIS' facilities had mixed results, going through a long, slow learning phase, with a few closing altogether after the project ended (4 out of 51).

The National Geographical Institute has been trying to make digital topographical base maps since 1992, but due to financial and institutional aspects, progress has been slow.[9] In 1997, most of the existing 1:50,000 maps were digitised in cooperation with the National Electricity and Telephone Company and the University of Costa Rica, while in 1998 a large government project funded a new institution for the creation of totally new topographical base maps (see Chapter 7).

Training

A typical 'project GIS' application would have one person working on collecting data, digitising and making maps. Sometimes this person also would have other tasks besides his GIS assignments. Many university GIS applications started with a person bringing the expertise from abroad. In most of these applications, the person worked with some colleagues and a group of students participating in the research. In an 'institutional GIS', GIS was often implemented inside a larger department or office for map making and information management. In these cases, normally a group of professionals was trained by foreign consultants or in special courses. Several users shared the GIS and databases, thereby making old mapmaking departments, or mapmakers, redundant. Clark (1998) noted that 'institutional' GIS applications often empower a group of technical mid-level bureaucrats to the detriment of high-level managers. This observation fits the Costa Rican GIS-landscape, since the notion of technological change or innovation sometimes led to resistance from superiors. Sometimes also a completely new group of professionals was trained and a new institution was created through the GIS project. This created tensions over responsibilities with 'old' planning institutes.

At first, most GIS operators were trained academics in an application field bringing with them the GIS experience from abroad. In a later phase, operators received their training as part of the national curriculum in different application fields. Looking at the GIS installations in 1997 we can still notice that around 70% of the GIS laboratory heads received training

[8] While Christiansen (1998) estimates that technical equipment for an average GIS project would cost between US$ 5,000 to US$ 50,000, large amounts of project money can be spent on information gathering, consultancies, training abroad, etc. The National University project 'TELESIG', for example, spent US$ 800,000 on a small pilot project on Natural Resources Management, but financed almost the whole laboratory, various seminars and training with this money (TELESIG, 1997).

[9] ministerial officials (M10, 21-10-1997; M20, 4-12-1997)

abroad or during a project from foreign experts. It must be noted that sometimes more than one person worked with the GIS, in which case newer personnel were trained by national universities or at the actual laboratory.

In the beginning, most training was given through US-development cooperation. After 1992, European Union funding grew considerably, while US funding stagnated. This can be explained by the changing relations between Costa Rica and the US, causing a drop in development aid after the Central American peace process. Funding by the European Union and the Costa Rican Sustainable Development Treaty with the Netherlands, after 1992, was responsible for most GIS training projects from Europe. More recently, the national training capacity has been incremented at the National University and the University of Costa Rica. The country also has two important Latin American training centres for GIS, with the Tropical Agronomy Research and Education Centre (CATIE) and the IDRISI-software training centre at the National University. Plans existed to start an international MSc program in GIS at the National University (UNA) in Heredia (Diaz, 1997b).

Table 4.1 Percentage of GIS Operators' Training Locations

%	
26	**North America**
40	**Europe**
6	**Latin America**
28	**Costa Rica**

(# 47[10])

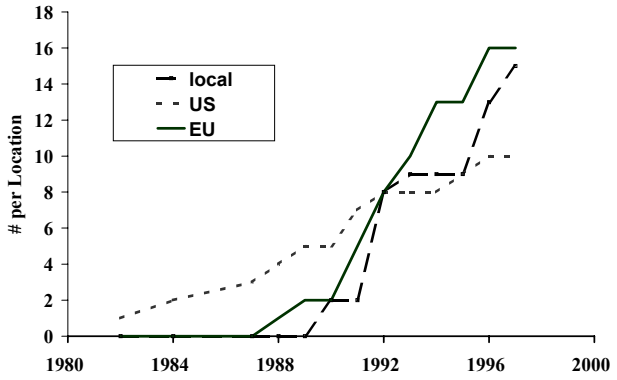


Figure 4.4 Cumulative Importance of local vs. international training (# 38)

Sectoral Applications of GIS

Having looked at GIS implementation in general, and investments and training, we will now move to focus specifically on GIS developments in various sectors. I have divided the GIS projects' application fields in four sectors: the agricultural, the environmental, the natural resources and the infrastructure sector. Given the pressure from donors, who were mainly financing environmental projects, it is no surprise to find that of all application fields the 'Environmental Sector GIS' is most developed. This sector included all GIS applications for the park and forestry system and NGOs working on environmental issues, etc. Table 4.2 gives an overview of the sectoral applications in Costa Rica in 1997.

[10] The differences in number of GIS installations in all tables and figures can be attributed to a lack of information on some aspects of the inventory and literature.

Table 4.2 Sectoral Application Field of GIS (# 51)[11]

Field	#	%
Agriculture	**11**	**22**
Environment	**33**	**65**
Natural Resources	**8**	**16**
Infrastructure	**13**	**25**

I define the 'Natural Resources Sector-GIS' as GIS focused on geology, climate and marine studies, while 'Infrastructure-GIS' is used loosely to encompass all GIS primarily involved in studies on electricity, road building, land registry and the mainly administrative municipal GIS applications. One GIS laboratory could, of course, work in more sectors, e.g. the case of a university GIS facility which was conducting environmental studies as well as geology mapping, while giving assistance to municipalities in setting up their land registry (Robinson & Solano, 1996).

Investments in the infrastructure sector were greater, due to the more all-encompassing institutional GIS projects of the Land Registry, Electricity Company and Housing and Urban Planning institutions. All these infrastructural GIS initiatives presented themselves also as partly working on environmental topics, reflecting the importance of the label 'environment' in Costa Rican discussions, and for obtaining money from donors and politicians.[12] It must be noted that, after 1997, with the growing responsibilities being allotted to municipal governments and renewed efforts to improve local tax recollection systems (chapter 3), many municipalities invested in GIS capabilities. Investments have often come from their own budget (Pujol, 1997; Orlich, 1998). This will make demand for 'infrastructural GIS' and training in this sector more important in the future.

If we look at the sectoral application fields of different types of organisations (government, NGO, university or commercial) we see an overall dominance of the environmental field. Only the relatively new commercial organisations had only one ‘environmental sector’-application. The NGOs were all environmental organisations. Their involvement in many projects supporting the Park System, in the first half of the nineties, stimulated their GIS development. Donors, the government, and the NGOs, considered GIS an important tool to improve the management of protected areas.

[11] One GIS location can have more than one sectoral application. For example, many university GIS laboratories have applications in the environmental, agricultural ánd the urban sector. Therefore, the numbers do not add up to 51 or 100%.

[12] The Registry saw the delineation of parks as one of its tasks, while they also assumed a role in a land tax system that was to be used for intensification of land use. The Electricity Company had one department with a GIS working on watershed protection issues, while the GIS for Urban Planning saw environmental planning as part of their tasks.

Table 4.3 Percentage of Sectoral Application Field of GIS per Type of Organisation (# 51)[13]

	Agri-Culture	Infra Structure	Environ-Ment	Natural Resources	#
Government	**26**	**35**	**57**	**13**	**23**
NGO	**0**	**0**	**100**	**0**	**8**
University	**20**	**27**	**73**	**33**	**15**
Commercial	**40**	**20**	**20**	**0**	**5**

The 'government' GIS applications were the most 'equally' spread over all sectoral application fields indicating a growing acceptance in all sectors of the benefits of GIS technology and projects. In the agricultural sector the Ministry of Agriculture was the most important GIS laboratory, with several persons being trained in the technology (Chapter 5). Other institutes in this sector, such as the Land Reform Institute, and the Irrigation and Drainage Institute, started later or have had many problems with the implementation of GIS (Diaz, 1997b). GIS use for departments responsible for geology and mining (natural resources sector) have been implemented very late in Costa Rica, due to institutional reorganisations (a new Ministry). In this 'natural resources field', GIS applications were predominantly developed by university departments. The Infrastructure Sector had an important impulse through a large project for a National GIS for Housing and Urban Planning (SISVAH), with the Ministry of Housing, funded by the Canadian government. Although the continuity of the GIS laboratory was problematic, the project stimulated other state institutes to start GIS projects themselves. For the universities, 'environmental field' applications were the most important GIS use. Many university GIS departments developed into a type of university-NGO for environmental issues, or began functioning, at least partly, as such. These GIS laboratories often sold training and data production services to the government, NGOs or other university departments and they competed on 'the market' for environmental projects. This already hints at a change in the way information was produced, something we will discuss in the last section of this chapter.

If we stop for a moment to consider that all of these GIS developments were taking place in a decade characterised by far-reaching neo-liberal reforms and economic crisis, we might wonder where all the money was coming from. The answer is that donors heavily supported the investments in GIS. In both the environmental sector as well as the infrastructure sector most investments were made through donor projects. First, I will try to understand why and how these investments influenced the implementation of GIS. In the next section, therefore, I discuss the reasons and motivations behind the introduction of GIS, the problems encountered during implementation and finally the uses assigned to the GIS products. Only after this discussion can we understand the consequences of the "GIS-boom" for Costa Rican information production.

[13] The rows do not add up to 100%, because some GIS laboratories work in more than one application field.

4.2 Motivations and Problems in GIS Applications

The Costa Rican GIS-boom was not unproblematic. This section takes my inventory of GIS in Costa Rica, and examines a range of responses regarding motivations, problems and actual applications. As a departure point it is important to highlight that many GIS projects, initiated in the nineties, were presented as a way of increasing efficiency of administration and reducing costs in internal planning processes (e.g., COTI, 1993; Munting et al., 1998). The argument of efficiency was in line with changes in the Costa Rican state system in the nineties (reduction of personnel and closure of departments and institutions). Many projects, however, were facing delays during implementation, and in the majority of organisations the picture of 'efficiency' was more a distant goal than an actual consequence of GIS (Diaz, 1997b; Fallas, 1995). Still, GIS was promoted and presented as an indispensable tool, and projects were introduced at a seemingly eager pace. This roused a number of persistent questions. What were the motivations of different actors behind the GIS boom, in addition to laudable project intentions, and can this explain the popularity of GIS? (4.2.1) What were the major problems that caused delays in implementation? (4.2.2) And what were the main results and applications of GIS once they were producing results? (4.2.3). Answers will provide a basis for understanding the consequences of the GIS boom for the Costa Rican 'information production landscape' discussed in the last section of this chapter.

4.2.1 Motivations for GIS implementation

To understand the different motivations for GIS implementation, I looked at different actors that were involved in the implementation process and use of GIS. Several actors around GIS projects could be identified. GIS operators often had to deal with direct office managers and/or policy makers, and colleagues. Government and donors were involved in negotiating which projects would or would not be financed, while international and local software hardware and consultancy companies were trying to develop the market for the new ‘business’ of GIS in Costa Rica.

GIS-Operators and their superiors

In the early phase – just as the first operational GIS in the National University introduced by Leyw - many implementations were stimulated by academics in the fields of geography, biology or natural resource management, using GIS in post-graduate studies abroad. Once returned to Costa Rica, these academics stimulated the 'superior technology'. They had often used GIS for specific studies, projects and goals within a university, or in their jobs within the government. Foreign experience was not only important to push the idea in their respective institutes, but also in terms of the contacts that had been established with potential partners in research and among donors. This made it easier to 'convince' managers and policy makers of the 'usefulness' of GIS.

Most of the money invested in the GIS in universities was coming from projects of foreign donors. One of the more successful laboratories received US$1.2 million for projects between 1990-1997. "The university administration cannot be against this GIS laboratory, because they didn't invest a penny in it... and they receive a fixed percentage for 'overhead' on all the projects we do with our GIS...".[14]

Although managers and policy makers often expressed doubts about quick results and benefits from GIS,[15] they welcomed projects as a way of receiving spin-off income or investments in their institute. During the 1990s, when there was far-reaching reduction in state (including the university) budgets, this argument carried a lot of weight. Any investment or project was welcomed, since additional perks such as cars (for data collection) and infrastructure (air conditioning, buildings) were considered 'GIS project' necessities (e.g., MIRENEM et al., 1995a; Laake & Rodriguez, 1995; Munting et al., 1996).

While some state employees were opposed to GIS because of the expectation that GIS would enhance control and supervision of certain tasks while causing the disappearance of others, many (future) GIS operators saw GIS-training as a way to increase their value. They saw GIS training as a means to make themselves indispensable in times of regular labour lay-offs (Diaz, 1997a&b). Many GIS-professionals who received training as state employees, later started working in the (better paying) private sector[16], or as consultants. GIS training, therefore, offered career enhancement and upward mobility.

Governments

For governments (1990-1998) GIS was also viewed as a way of changing certain aspects of the organisation of planning and control. The many projects in the environmental sector often had explicit aims of changing administration of e.g., forests, park controls, or legitimising land-use change within protected areas. For the Figueres government (1994-1998) GIS was seen as strategic in 'centralising information, while decentralising actual practices'.

A larger (World Bank) project coupled drastic cuts in personnel, while investing in large information projects (chapter 5). It was suggested that GIS would help to keep central control over what was happening through the information generated by GIS and computer

[14] GIS expert (U2, 1-09-1997)

[15] mid-level managers and policy makers (e.g. G9, 22-10-97; IFI3, 18-08-1997; M12, 9-02-1996; M17, November 1998; M38, November 1997; AI1, 13-06-97). Policy makers often thought that 'the GIS-technologist always presented things too optimistically', and '..that they just had not figured it out yet' (M12, 9-06-96). Still, they expressed confidence that in the future GIS would function well.

[16] The private sector was still very small, and in 1997, I identified only 5 commercial firms using GIS. Most people who worked as GIS operators in the early 1990s left their projects or their government agencies and went to software companies (NGO2, 7-03-1996), while in the late 1990s trained personnel sometimes changed their stable job for an uncertain existence as private consultant (see bellow).

networks, "now that they cannot phone to the regions anymore because of the personnel reductions and privatisation [17]". In another project the GIS coordinator remarked: "..people from the regional offices are resisting the standardisation we introduce with our GIS, because they feel they will loose control and independence..".[18]

Governments presented GIS as a neutral tool that would benefit and modernise the organisation. Projects were formulated in technological terms (if formulated at all[19]) and during implementation most of the time no reference was made to possible organisational changes that could go together with GIS. Projects that introduced unpopular measures could thus be presented as innocent and without impact.[20] Neutral and attractive technology implementation removed the political sting from decisions about institutional restructuring.

Donors

As mentioned before, donors had a dominant role in the promotion of GIS projects. Why was GIS attractive for donors? Most GIS projects (over two thirds) received funding from international organisations or bi-lateral donors. Only in a later phase were some private initiatives and small GIS applications within government paid out of regular budgets. All major 'institutional GIS' and many 'project GIS' in the environmental sector were financed largely by the generous support of donor countries. With its education system and stable political climate, Costa Rica was attractive to donors. It was a successful model for the promotion of new technology, especially in the environmental sector. The United Nations, the World Bank, FAO, IADB, Conservation International, the International Union for the Conservation of Nature (IUCN) and many bi-lateral donors all selected Costa Rica to experiment with new GIS technology[21].

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[17] This remark was made by a World Bank official (IFI4, 4-11-1997). In a way the idea is confirmed in chapter 5 and 7, where GIS is seen as a potential asset for 'centralising information', while decentralising the actual administration of projects and tasks.

[18] GIS operator (M27, 2-11-1997)

[19] In many smaller projects, GIS was seen as 'just buying a computer and software', so no official document on implementation was even made. This reflected the perception that GIS was just a tool, that it would easily be used as an add-on to 'business as usual' (this also sometimes led to frustrations of GIS-operators, who could not live up to the expectations: e.g. N20, 5-12-95; N16, 25-09-96).

[20] In the policy around Conservation Areas the government made the explicit choice to invest (and have donors invest) in NGOs. GIS was often an important component that would lead to better management of the areas. The concentration of information made the NGOs (for a while) the most powerful actors in these areas, giving them prestige and resources to determine new policies and attract new donor funding.

[21] One of the first 'analytical' GIS projects was a project for watershed protection of the Organization of American States (government official; G9, 22-10-1997); the Organization for Tropical Studies GIS-initiative was linked to USA-universities; the Tropical Science Center and Conservation International stimulated GIS; IUCN had a Costa Rican office with GIS facilities that subsequently promoted GIS use in Central America (Junkov & Rovinski, 1993). Two of the most successful GIS laboratories in university centres, the Centre for Research on Sustainable Development (CIEDES) of the University of Costa Rica and the Laboratory for Teledetection and Geographical Information Systems (TELESIG) of the National University also were created as a spin-off from the 'conservation link'. The United Nations Environmental Program selected Costa Rica and Nicaragua to experiment

For donor countries (and policy makers) GIS technology was interesting, because they were pressured by national and international environmental movements to do 'something' (Kaimowitz, 1996), and with the new technology large amounts of money could be spent without really getting involved in controversial measures.[22] Information production was widely accepted as an important (and neutral) activity, and although land-use planning itself was unpopular in neo-liberal doctrine, GIS itself had no 'market distortion' consequences. Moreover, GIS could even support market mechanisms, by helping create more transparency in, e.g. land markets (COTI, 1993) or 'tradable carbon offset' certificates (chapter 6). More private involvement in information production (information services) could even stimulate the breakdown of tasks and responsibilities of central state institutes and give decentralised governments and private organisations an alternative to central state assistance. Finally GIS was attractive because the money spent in GIS projects is defined as 'investment', instead of 'recurrent costs' (e.g. PASA, 1991). Donors preferred spending money on investments because this prevented discussing the issue of who would pay for the recurrent costs after the project phase.

Commercial firms

In the larger projects, the donors set the conditions for expenditure. Often software, hardware and consultancies had to be paid for in the donor country (or countries in the case of the European Community) (Diaz, 1997b). In addition to formal requirements of donors, projects brought a specific technology or software from the donor country. A Canadian project with a new satellite system would imply that in the future the receiving country would probably keep using the same software, satellite images and services.

> *IADB officials stated at the "Conference on Global Environmental Projects: A Multibillion Dollar Market for U.S. Firms" that the Banks' Energy, Environment, Sanitation and Urban Development projects, in the nineties would be worth between 1.2 and 1.6 billion dollars a year, of which the majority will go to national and international bidding contracts*[23]

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with a bi-national watershed project. Costa Rica was one of the first regional countries to do a baseline study on climate change gases funded by the United Nations Development Program (IMN, 1996). Conservation International tried out its software in Costa Rica. Canada selected Costa Rica for its new satellite project 'Globesar', in 1992, while the Dutch Kadaster advertised their Costa Rican experience as a way to get a share of the market of projects in Central American countries (Alers, 1994). FAO funded the first GIS in the Ministry of Agriculture in 1989 (Project official; G11, 12-12-1995) and stimulated forest monitoring with satellite images in the early nineties (ministerial offical:M11, 19-02-1996). The IADB stimulated GIS use in all its projects for 'ordenamiento territorial' (bank official; IFI13, 18-08-1997).

[22] Taylor and Buttel (1992) pointed to the fact that in discussions on global environmental change the focus moved away from direct (controversial) interventions in the field. New research on global environmental problems tended to focus on 'common interests' and 'technocratic solutions', preventing a discussion on winners and losers of environmental problems. With the focus on 'global' and 'general' problems, the local and unpredictable conflicts of interests were not studied any more. Also, by limiting research to 'technical' and 'global' problems, the links between, e.g., the national debt problem and the environmental degradation disappeared from the agenda.

[23] In an example, they estimated that around 75% would go to contracts for goods and services. IADB also had a condition that the donor money was to be spent in its member (donor) countries (Diaz, 1997b).

(Vaughan & Ardilla, 1992). GIS and information production were always part of the examples given (ibid.). It is widely known that international financial organisations organise trips to visit software companies or functioning GIS installations in donor countries to convince Third World policy makers of the usefulness of the technology (e.g., Sahay & Walsham, 1996). Large projects often include more important amounts for information gathering and consultancies: the National Land Registry project of 1991, for example, had a total budget of around US$10 million, of which Holland donated 65 %. Most of this money was spent on Dutch consultancies and on the Dutch KLM contract for aerial photography (MIDEPLAN, 1997).

Not only donors, foreign academic and commercial firms have been involved in the business of GIS implementation. Several operators pointed to the pushing of GIS by Costa Rican software and hardware vendors, who often promise fast and easy results (see also e.g. Rodriguez, 1996). Up to a certain upper limit[24] the software and hardware companies benefited from state institutions' obligation to buy software through national channels (Diaz, 1997b). The costs of soft- and hardware were higher in Costa Rica than abroad and, therefore, many universities and international aid organisations tried to buy their software in the USA, or receive it partly as donations (ibid.).[25]

The Motivation(s) for establishing GIS?

In summary, we can say that in Costa Rica, the 'GIS-boom' should be understood predominantly from its international position in nature conservation. While in the nineties the country did not receive large amounts of donor money, donor assistance for environmental projects (and GIS), especially around the UNCED conference in 1992 and the Kyoto Conference in 1997, was still considerable. During this period most requests for money from Costa Rica were formulated in 'environmental terms', while donors saw in Costa Rica the ideal experimentation ground for its environmental and GIS projects. This section has shown how this donor-push generated different motivations. The official (and to a large extent sincere) motivation of most GIS projects was the promise of efficiency. GIS projects were convenient for different actors, however because of e.g. the pressure on donors to spend large amounts of money, or the self-interest of involved parties. The differences in motivations makes it difficult to talk about 'one' project motivation,[26] and to understand implementation we have to 'look behind the curtain' of the interests involved in the process of implementation. Why was there so little success given this generous support? To understand this question we will discuss the problem as perceived by GIS operators in the field.

[24] A limit mentioned in one of the meetings I attended to was US$10,000 (TERRA meeting notes, 7-7-1997), which put individual smaller projects that wanted to buy one computer and software well under this limit.

[25] IICA meeting notes (24-08-97)

[26] Organisation and management theories on GIS implementation defined often 'one' ideal motivation for GIS implementation (Chapter 2).

4.2.2 Perceptions of Problems during GIS Implementation

The frequent implementation of GIS in land-use planning during the nineties was not without problems. My research questionnaire signalled many problems of GIS use on the work floor. In this thesis, the perceived problems will be used for understanding the changes in how the GIS community was dealing with information production. This does not mean that I think that problems were 'only opinions of GIS operators'. On the contrary, I think the perceptions of the GIS community as a whole provide insights into trends and new accepted ways of dealing with digital information problems. This will constitute an important background for the case study chapters.

Table 4.4 Perceived Problems with GIS implementation in Costa Rica

	No Information Policy	Lack of Finance	No Official Data	Data Exchange	Data Quality	Training Personnel
IUCN (1993)		X		X		X
Consultora 4 (1994)		X	X	X	X	X
Fallas (1995)	X	X	X	X	X	X
Rodriguez (1996)		X		X	X	X
Gonzalez (1997)	X	X		X		X

Several overview studies have been done in Costa Rica about GIS implementation and its most important bottlenecks as perceived by GIS operators. The problems signalled in the different studies are summarised in Table 4.4. We see that a number of inventories categorised the most common problems as being the high costs of initial investments, financial stability for GIS operation after project money dried up and problems around data exchange and training. Although during the early nineties, financial problems were linked to the high cost of the equipment, later this argument was used less, reflecting the drop in price of computers and availability of cheaper software systems (Christiansen, 1998). In later overview studies, financial problems were related to 'maintenance' and the fact that once a project terminated the money for maintaining the GIS normally dries up. This problem is related to the afore-mentioned 'lack of policy on information management'. After discussing this, we will look at the problems of 'training' and 'data'.

Lack of Information Policy

The 1990s had great impact on the policy factors influencing GIS. Years of structural adjustment had eroded the finances and institutional environments essential for updating existing information. A result was fewer initiatives to gather new information.[27] The overview studies (Junkov, 1993; Consultora Cuatro, 1994; Fallas, 1995; Rodriguez, 1996; Gonzalez, 1997) highlight that there was not enough investment in the recurrent costs and

[27] director of the National Geographical Institute (Bedoya, 4-12-1997)

that this was one of the most important policy problems. Making the problem worse, projects in various state institutes, funded by different donor organisations, were not coordinated, often leading to duplication of efforts, overlap in aims, applications, and software but also different standards and meanings concerning e.g., '*ordenamiento territorial* (spatial zoning)' (Fallas, 1995; Cotera, et al., 1998).

Other 'policy' problems mentioned were poor payment of GIS-operators and lack of task definition. GIS operators were charged with GIS responsibilities in addition to their 'normal' activities (Fallas, 1995). The problem was more severe in the government and (public) university sector. In the government sector GIS development was often very slow, often depending on the interest of one person in a department. Because of structural adjustment programs, the public sector could not hire new people (or define a new position), and money was scarce, magnifying the problem (Diaz, 1997b).

> *In 1992, the Institute for Irrigation and Drainage had a project funded by the Japanese Development Organisation, JICA. Several persons from the institute knew of GIS technology and thought it would be useful. In 1994 they received a donation from Japan, with a short training course. All equipment together was worth around US$ 275,000. Six persons took additional training at the National University. Of these 6 persons, only 2 remained. They started with digitising basic information, but at the same time they had more important tasks as professionals in hydrology and agronomy. Because of the 'labour mobility' programs many people who were working for the institute left. As a result, the people who remained were assigned more responsibilities. The GIS was hardly used, and to add insult to injury the computers' optical device broke down, with disastrous consequences for information storage and back ups. They lost almost all data. In 1997, the GIS was hardly used. The National University rented the hyper modern electrostatic plotter for specialised jobs. This generated some income for the maintenance of the plotter.*[28]

In academic institutions many professionals complained about their universities. They claimed that a lack of investments meant that they themselves had to spend time and energy on project acquisition. Projects were perceived as a core task of the GIS operators. As a result, GIS courses in the universities were offered as an additional 'fringe' option, when possible, rather than as a core component. The head of the GIS department of CATIE, for example, mentioned that CATIE especially focused on practical applications of GIS, with most of its activities being part of some donor or government project.[29] Consultants complained about this, pointing to the fact that universities worked with laboratories already equipped and with students who did part of the work. This would make universities cheaper than private consultancy firms making it difficult to compete.[30]

[28] government professional (AI8, 27-08-1997)

[29] U8, 28-10-1996

[30] various GIS experts (U2, 1-09-1997; U5, 18-08-1997; U7,13-08-1997; G 26-08-1997; U8, 28-10-1996)

Training Problems

Beyond policy problems, training GIS professionals was perceived as an important obstacle. Many organisations faced the problem of lack of adequate personnel. Project managers and high level bureaucrats often did not perceive the importance of GIS training. They thought that a short training package offered by software companies would be enough to run a GIS for the project. This often caused delays in project execution and contributed to a sense of disappointment.

> *The UNEP project for the Watershed of the Rio San Juan faced these problems: "The results were poor because we had to do in 7 months, what we planned to do in 17, because of the delivery problems of the software and computers. ... [O]ur GIS-operator was not familiar with the software we bought.., and his training was too short. ..... He did not know that if you change the name of a variable, you will loose the attributes connected to it; this once forced us to go back from Nicaragua to Costa Rica, in the middle of the night, to get the old back-up files."*[31]

Despite the fact that many heads of GIS laboratories were trained in foreign countries (70%), the high demand for GIS specialists and professionals with GIS experience still caused problems (Diaz, 1997b). Well-trained people were often promoted to higher level positions, leaving actual GIS-operation unstaffed. Successful GIS laboratories also had difficulties in finding and retaining qualified personnel. As suggested earlier, there was a consistent brain drain from the government and universities (where salaries are lower) to the private sector and NGOs (Fallas, 1995; Diaz, 1997b).

Data Problems

GIS computer technology was often praised for the fact that it entails explicit and transparent data management choices. Throughout my inventory of GIS projects in Costa Rica, however, this idea was repeatedly contradicted. Various respondents highlighted that the GIS computer data created dependency on individual practitioners. Where formerly maps and 'hardcopy' paper files existed, departure of an information expert would have less impact if a knowledgeable person could reconstruct data on the basis of the data remaining behind. In the case of digitised data, the transfer process was absolutely essential. Sometimes data was lost or became inaccessible because key persons changed their jobs. There were many stories of people who left an institute, without a proper transfer of responsibilities or explanation of how data were organised. Also information necessary to understand the data was often not present, and sometimes data sets were even locked with passwords, or tapes were lost altogether (Hall et. al, 2000c). Problems were caused by a lack of good data structuring, storage and backup. There were often no adequate descriptions and definitions of variables.

[31] government official (G8, 24-06-1997)

File names were often not logical and descriptions of files and their locations were lacking.[32] With often only one person responsible for the system, data management became very vulnerable. Some people suggested that there would be more digital data about Costa Rica abroad than in the country because Costa Rican counter-parts on many projects would have already lost the data.[33] Although the 'information flight' might be true in some cases, the problem was also often that simply nobody remembered that the data were produced or where they were (Gonzalez, 1997; Hall et al, 2000c).

Because of the difficulties in data production at the beginning of GIS projects, government institutes and donors often hired NGOs, universities or private consultants to deliver ready-made information services. One problem with this practice was the difficulty in defining and checking data standards. This problem was aggravated by the fact that sometimes the services were provided by un-experienced people (and students).

> *Some university facilities were working over-hours to execute the many projects. Universities often worked with 'cheap' students to do part of the work, as part of their training requirements. The many well-trained GIS operators with PhDs and MScs from foreign universities often did not have the time to do the 'dirty' digitising job. This sometimes gave problems for the data quality, if students who were first time users were less aware of the importance of the accuracy of digitisation for later analysis, overlays and data-exchange. The Rio San Juan Project hired services for base mapping from the National University, but "although they are very qualified, the product was not optimal, …because they were in a hurry"[34]. Looking at the maps, one could identify several errors: rivers ending in the middle of no-where; roads that were not well connected; and some lines that were digitised in a straight line or with sharp corners where this could not be expected. The project only discovered after the contract with the university had ended, that some of the digital information elaborated by the project already existed elsewhere.*[35]

Another aspect was data quality. Data standards and quality in GIS are important to be able to compare, overlay and analyse data. Different GIS users faced the problem that topographical maps were out of date. Also many problems existed with the conversion of

[32] Some examples mentioned during the inventory for this research were the numbering of data files, instead of giving logical names; not cleaning up errors in relational databases, making it years later difficult to understand which database was important and which was from earlier trials and mistakes; loss of whole data sets because of deleting vital parts; lack of transfer of digital data from foreign projects.

[33] This kind of comment was made in international financial organisations, but also in by high-level state officials (IFI4, 4-11-1997; M5; 5-05-1996). Some examples of data abroad were a national data set in the University of Ohio, data sets at the University of Wageningen or the University of Texas. Before the digital data set of the topographical maps was given to the National Geographical Institute in 1997 by the Army Mapping Service of the USA these maps were unknown in Costa Rica (M20, 4-12-1997).

[34] project official (G10 25-06-1997)

[35] several technicians and high-level government officials (G7, 23-04-1996; G8, 24-06-1997; G9, 22-10-1997; G10 25-06-1997)

data between the two 'officially' used map-projection systems in Costa Rica (Lambert and Universal Transverse Mercator-CR)[36]. Because there was no standard digital base map available, many versions of e.g., 'the borders', 'roads' and 'cities' of Costa Rica existed, in varying degrees of quality. Also, different institutes and organisations needed different kinds of data and at different levels of detail and for some uses (and quality levels) data might not exist at all.

For most organisations, standard information was seen as necessary. Operators indicated that they would like to have standard topographical data on scales of 1:200,000, 1:50,000 or 1:10,000. Where there was a need for standard data of a certain scale, the greatest problem was the absence of digital maps with basic information, such as topography, soils and land use. The production of 'official' and approved information was very slow. In Costa Rica attempts in the 1990s, to make a standard digital topographical map did not receive strong government support. Moreover, activity was fraught with many of the problems just mentioned slowing down the process even more. Because of lack of support the National Geographical Institute began the digitisation of the maps through different projects, and with financial support from other institutes. The Institute initiated the digitisation of the 1:10,000 maps with the Infrastructure and Housing project 'SISVAH'. The SISVAH project would digitise the information in exchange for the right to sell it. The Geographical Institute would receive a percentage of the sale price. The project failed because the products were of a low quality and SISVAH forgot to digitise the maps with the geographical coordinates, which made them useless for 'real' GIS applications. On other occasions, data produced by the state system was handed over to individuals looking for information. Later, the same information was offered for sale to state institutes for high prices. Some GIS operators suggested that with the explosion of GIS projects, and demand for information, digital databases had become big business in Costa Rica and information a commodity.

> *In one state institute the GIS-operator highlighted " ...a private software salesman tried to buy our database in exchange for new versions of software, with a license..."*[37]*. The same salesman later tried to sell a topographical database 1:200,000 from a government project, that he had received 'under false pretexts' from a willing GIS operator. The government institution successfully demanded that he would immediately stop the sale*[38]*. University GIS laboratories were also collecting data, to be used and resold in different formats. A common practice was that data collected in one project would be used (and resold) again in future applications.*

[36] Although in theory conversion between projection systems should be easy with help of a GIS, inexperienced GIS-operators will make mistakes if they don't understand the consequences of projections for the coordinate system. This problem would not exist if they (inadvertently) would not have to work in two systems.

[37] professional from autonomous institute (AI8, 27-08-1997)

[38] professional of government project (G10, 22-02- 2001)

The result was that most GIS-laboratories would agree to hand over information only in case of reciprocal exchange, after formal letters of agreement, or when it concerned a known and trustworthy person, who would be part of an existing circle of colleagues. Understanding the mechanics of these kinds of complex data problems was important because they underlie motivations and perceptions regarding GIS implementation and application. It was precisely these dynamics that led to scenarios where efforts to access data might be met by a gatekeeper claiming "…Ministry X cannot let out its data because it is being revised or it is politically sensitive; Ministry Y is happy to give you its digital database, but 'everyone is too busy' to make it available; private environmental firm Z does not want to let out its data because it was very expensive to collect, and they have not yet derived their full value from it..." (Hall et al., 2000c:160).

In summary we can say that GIS implementation in Costa Rica faced many problems. Costa Rica did not have major obstacles with regards to infrastructure, electricity or hardware, as signalled in the literature on many other developing countries. Problems had more to do with structural issues, lack of policies for information production and use, and because of problems of data standards and exchange. Although many GIS projects found difficulty meeting expectations raised at the start, only 4 out of 51 GIS projects stopped functioning altogether, as a result of these problems. This shows that after many delays the departments or organisations continued even without the full support of policy makers.[39]

4.2.3 Actual applications and products of GIS

The perception of problems as signalled by GIS operators in my inventory has been important for understanding policy and data issues. The perceived problems, however, often do not mention the tension between the goals of the GIS during project formulation and the actual results. In our inventory we asked, therefore, empirical questions about the actual products that were made, and for examples of the use of these products. This section describes and analyses the answers.

Many GIS operators consulted in the inventory referred to the functional changes GIS introduced in information production and map making: data management, analysis and output generation (maps). Looking at these technological changes in various GIS locations, we identified variation in the relative importance that GIS operators gave to such innovations. Large institutional GIS projects in the infrastructure sector placed more emphasis on database management benefits from GIS (for example in organising and transferring data on land registries or administering electricity users). For GIS applications

[39] From our own inventory it seemed that the lack of policy and money had improved slightly by 1998, especially in local state institutions, were smaller GIS projects were started through local institutional budgets (Diaz, 1997). Of the 47 GIS projects with available data 12 GIS-laboratories were initiated recently with local funding.

linked to environmental issues and land-use planning, 'analysis' was seen as very important. Map making was recognised by all GIS laboratories as an improvement made possible by the technology[40].

Most GIS laboratories saw improved analytical possibilities as an important goal, but Fallas concluded from a Costa Rican workshop in 1995, that only 50% of these laboratories had reached an operational use of GIS. Most GIS laboratories at that moment were still 'in the data gathering phase' (Fallas, 1995). In my 1997 questionnaire, around 75% of respondents mentioned they were actually using GIS for (sometimes simple) analysis. Although many organisations mentioned analysis as their main goal in GIS use, goals were often changed during the implementation process once analytical applications appeared as too ambitious due to unrealistic expectations, implementation problems or lack of information.

> *The United Nations Environmental Program (UNEP)-project for the International Watershed of the Rio San Juan collected digital information for two countries (Nicaragua and Costa Rica). "You always need maps for any 'ordenamiento territorial'-project , ...so we needed a GIS, and through the GIS it was easier to bring the information from two countries together, ...it forced people to come to common definitions"*[41]*. The problem was that not much information was digitised, and information was often difficult to obtain... Therefore they changed the objectives of the project from making analysis to making an inventory, and they hired outside expertise from the National University to collect the basic information.."*[42]*. Finally, just before the project's termination, the project director hired a consultant, and together they used simple overlays of part of the data to make a 'priority map'. "It probably would have been cheaper to make the maps by hand, but then, in the end we wouldn't have had the possibility to do our quick [overlay] analysis, and we can use the information in the future if the project will be funded for a second phase...".*[43]

Our inventory confirms that indeed GIS applications implied various functional changes. The consequences of these functional changes were interpreted in different ways by various actors involved in GIS implementation. The answers of GIS operators often reflected 'potential changes' (such as the analysis, efficient data base management, and improved mapmaking that are always part of 'textbook' GIS descriptions). For this reason, our inventory went a step further to try to reveal discrepancies between potential and actual applications. During interviews I focused also on empirical results of GIS.

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[40] Remote Sensing for monitoring land use changes and research was almost only done by university centres. Applications of remote sensing in government were limited to a few examples, as e.g., in the new Canadian project on Radar Remote Sensing that financed both government and university research (IGN, 1997).

[41] government official (G7, 23-04-96)

[42] government official (G9, 22-10-97)

[43] government officials (G8, 24-06-97)

The examples of GIS-use given by the GIS operators were classified according to the following actual application categories: policy applications, applications for internal planning, administration education, consultancies and fundraising. Because institutional embedding of GIS was an important factor for understanding its actual implementation I made an effort to differentiate between GIS use in different organisations, such as the state bureaucracy, universities, NGOs and government projects.[44]

Table 4.5 Actual Application of GIS (in % of total) by Type of Organisation (# 38)

Application	Policy	Internal Planning	Administration	Education	Consultancy	Fund-raising	#
State	**60**	**60**	**60**	**7**	**20**	**7**	**15**
NGO	**57**	**86**	**43**	**29**	**71**	**43**	**7**
University	**60**	**10**	**20**	**90**	**50**	**0**	**10**
Government	**80**	**80**	**60**	**0**	**0**	**20**	**5**
Average	**61**	**55**	**47**	**32**	**34**	**13**	

The results of the inventory indicate that the single most important reported use of GIS in Costa Rica was 'influencing overall policy'. This response was most common among GIS laboratories involved in land-use planning or environmental regulation. This reason was often mentioned in combination with superior presentational possibilities. The combination of new analytic techniques with presentation possibilities was also considered important. This was often referred to as useful for convincing policy makers of the urgent need to act. Both high level officials and GIS operators used these arguments as an important legitimation of GIS projects.

The figures give some indication that 'government projects' put more emphasis on influencing policy, reflecting the tendency of projects to be used as vehicles for structural change (see below 4.4). The inventory revealed that universities presented their GIS primarily as used for education. To a lesser extent they mentioned GIS use for consultancies. As signalled above, however, these consultancies were often of crucial importance to generate income for the survival of the GIS laboratories. Universities often used their GIS for influencing state policy, instead of for academic research.

In the inventory it became clear that ‘internal planning’ was not important for universities. This application was important for state GIS laboratories, NGOs and government projects. In these cases GIS was often used for a wide variety of tasks, such as selecting intervention areas, or planning electricity lines. ‘Administration’ and database management applications were used especially in 'institutional GIS' for purposes such as the administration of

[44] I mean projects initiated by the administration in power, in relative independence of the existing bureaucracy (not to be confused with my earlier distinction between 'institutional' and 'project' GIS).

electricity networks and users, land registry, forest registry or for updating topographic maps. It is curious that despite the fact that 'administrative' applications could be very important and useful in areas such as monitoring protected areas or evaluating performance, very few respondents indicated this. This omission underlined their perception that it was not a prestigious application.

'Administration' was important in state and government projects, however. This was often related to 'efficiency' goals. The actual application of GIS for administration was not popular with professionals working in organisations where GIS was implemented, because of its potential use for monitoring performance of people in organisations. Because of the 'neutral' administrative aspect of GIS conflicts within and between organisations could sometimes arise.

> *The use of GIS will "give the Conservation Areas the techno-scientific instruments and organisational methods" to improve functioning of the Regional Conservation Area Offices (MIRENEM et al., 1995a). GIS will be used for the control and monitoring of forestry permits, for the agro-ecological zoning of restricted areas and for the scientific or military planning of patrolling routes of park officials (Munting et al., 1996). In the Project for the Tortuguero Conservation Area, the first experience to implement the GIS led to some difficulties: "...We used GIS for making a forest vegetation map and checked the forestry permits with the land classification and this vegetation map... Although the information needs to be more detailed, it at least gives an indication.... We discovered that the Forestry Department had given out forestry permits on land classes for protection.... two foresters were fined and sent home as a result, but this also meant that the cooperation between the project and the forestry department ended.." Project evaluators mentioned that the door between the Tortuguero project and the Forestry department was 'permanently locked', although they were in the same building (Munting et al., 1996). "...They just didn't get it, with these instruments they could control the powerful forestry sector...but they didn't want to cooperate with us, and stopped all information exchange. The maps of forestry permits of 1994 which would be included in our Atlas also never were published...".*[45] *Later, after 1997, more successful attempts were made to implement a new GIS for forestry monitoring under direct control of the Forestry Department.*[46]

A last important issue from the inventory was that a third of all GIS laboratories saw GIS as useful for consultancies, indicating their perception that there was a market for studies using GIS. Many donor funded projects demanded information studies, making the sale of information one of the sources of additional income essential for the survival of GIS laboratories, especially in NGOs and universities. Also, several NGO projects used the final

[45] project personnel (M6, 24-04-1997).

[46] personnel from the Regional Office of the Ministry (M40, 7-10-1997).

GIS-maps of one project for producing proposals for another. In this way, these answers reflect the fast development of GIS and the large amount of available donor funding. This seemed to have led to an emergent 'market' for information products.

In this section we have looked at the results of our inventory regarding actual GIS applications. The most significant finding was that most GIS products were used for 'influencing policy'. But this would seem to contradict directly with claims of a renowned report evaluating that " ..in the majority of the cases technical studies are not used in practice.." (Fallas, 1995). Celis (1996) nuanced the impact of GIS studies when he remarked that although it is not possible to establish a direct relationship between environmental monitoring and policy decisions, the environmental studies did create discussion and general awareness amongst the country's intelligentsia, influencing indirectly law making and institutional change. It would seem as though this contradiction requires a closer look at what is meant by claims that most GIS products were used for influencing policy. We can only answer this by focusing on the use of GIS in its entire context, as will be illustrated in the upcoming case studies. At this moment, however, we are only establishing the influence of GIS implementation on information production.

4.3 Changes in Information Production for Land Use Planning

After the description of the way in which GIS was introduced in Costa Rica we have to ask how implementation has changed in the landscape of information production. Has the technology changed the way in which people exchange data, analyse it? Was it 'just' a technology that enables "doing more of the same", or did it actually change the use of information products for land-use planning and policy? We have to look at the technological aspects as well as the organisational changes around GIS implementation to get a general indication of trends that answer these questions for the Costa Rican case.

4.3.1 Technological aspects

During the 1990s, the majority of the GIS laboratories graduated from a 'learning phase' to a more 'routine application phase'. Many laboratories, however, were still fighting for budgets and had problems with becoming fully integrated into their respective institutions. GIS did not imply immediate drastic changes for these laboratories, but actual mapmaking was significantly influenced by the new GIS technology.

It is difficult to generalise about the different GIS locations and applications. Our inventory indicates that the majority of the applications were primarily continuations to execute 'old tasks' with new technology (Diaz, 1997b). Prior to the introduction of GIS maps 'traditional planning and analysis' also aimed to change policies. GIS was expected to have the

advantages in terms of being timely, analytical superiority and aesthetic attraction. These potentials have not been reached (by the late 1990s) due to implementation problems, and the fact that information was often simply not available. In general, the analytical potential of GIS was still not fully developed, and most 'analysis' was done using GIS for 'traditional' overlays. In other words, at most GIS locations the technology was used for "business as usual", but in digital form.

In less than half of the locations, and especially in the more administrative GIS applications, GIS induced some qualitative changes in administration process. These organisations were doing "traditional things differently" (Diaz, 1997b). For example, GIS helped with making automatic links between databases, it accelerated storage and access of plans for administration, and it gave direct results of summary statistics of surface areas.

We estimate that only around 25% of the GIS locations had developed new activities. In 15 % of the cases, these new activities consisted of taking on new tasks as a "spin off" from GIS implementation. Examples of these new tasks were monitoring of forestry permits by organisations that did never had done this before, or the creation of a GIS consultancy, or a University Department that did not exist before. In 10 % of the cases, the new activities consisted of applying new technological possibilities, like satellite use in weather forecasting or precision agriculture.

In general, we found that GIS did have an important impact on map making. First, with the growing introduction of GIS the profession of "map drawers" almost disappeared, because any GIS operator could produce beautiful colourful maps. Sometimes there was a danger that this easy automatic map making led to maps without content or with errors in accuracy and projections.

> *While most GIS operators were conscious of the principle 'garbage in garbage out', we found seen several examples where "nonsense maps" were used for convincing policy makers, politicians and funders of the necessity to do more research or to continue projects. Other problems with automatic map making included lack of understanding of map projections, which showed that GIS operators sometimes did not completely understand the technical aspects of what they were doing. Older professionals complained about the fast introduction of computers and GIS. "For analysis [interpretations] you still have to use your head", and " ..those young people think they can do everything with their 'maquinas'....Making a map is more than 'pushing buttons...people nowadays don't understand anything anymore about map projections and geodesy".*

A second impact of GIS on mapmaking concerns the distribution of maps and information. Before the use of GIS, information 'products' were often simply the finished end product of a final map, connected to an end report. These maps were normally distributed to libraries and archives. In the 1990s, few paper maps appeared in the many new studies, because with

the introduction of GIS, often only a single copy was made. Sometimes 'maps' were only available in digital format. A reprint was often difficult to obtain. Getting digital data, however, was nearly impossible.

Many authors suggested that the digitisation of data cause more and easier access to information (Clark, 1998; Hassan & Hutchingson, 1992; Burrough & McDonnell, 1998). As we saw in the paragraphs above, the problems with GIS in Costa Rica were often related to data exchange. GIS had led to a culture of suspicion and secrecy, instead of better access. In our inventory, laboratories claimed to be afraid that information given to anybody would lead to commercialisation of this information without rewarding the makers/owners of it.

> *Before the introduction of GIS, maps contained coded information for a wide variety of users. Now, with GIS, the raw data could be used very easily for different applications. In other words, we can say that GIS is making it possible to adapt the information products to the exclusive wishes of a client, while at the same time easily storing the raw data indefinitely for other future uses. The fact that the product can be adapted to the needs of the client means that the product will be less useful for third parties. In this sense the GIS can change information into an exclusive product that can be sold as a service.*[47]

As previously mentioned the context of structural adjustment and a push by environmental movements resulted in donors seeking investment opportunities in GIS projects, while there was pull from institutions looking for new sources of financial support. This created a demand for digital data and experts, which did not reflect a 'real market', but certainly meant a commodification of information. Although in Costa Rica there was no 'real market' for information, with the growing use of consultancy services in donor and state projects, information could sometimes be sold several times in different projects. Many GIS laboratories 'hoarded' information, as a strategic asset for the future. This artificial scarcity also presents us new challenges for understanding how GIS implementation will change the organisational aspects of information production.

4.3.2 GIS influence on Organisation

Before the 'GIS-boom' in the 1990s, information production was mainly a task of the state, officially coordinated by the National Geographical Institute. As we saw in the previous chapter, the introduction of GIS went together with reduction in state bureaucracy and an increase in the involvement of emerging NGOs in environmental management. These NGOs often collected information on environmental issues. NGOs stimulated the introduction of GIS for environmental planning, but GIS also enhanced their power and prestige. The state

[47] Rhind (1991) disagreed with this idea because 1) information does not change during use (and is often durable) 2) information distribution does not involve any costs 3) the utility and value of data are related to the expertise of the user 4) value often depends more on the coupling of databases, not one single database 5) the unity of information is difficult to measure (how expensive is a digital line of one meter?) 7) if you use supply and demand some areas will never be mapped.

was deregulating and privatising many tasks, and information production was being linked to schemes of 'cost recovery'. The Costa Rican state (as discussed in chapter 3) has been the motor for social and economic development and a frontrunner of forces promoting modernisation and planning. These traditions have permeated all aspects of social and technological advancement, such that among bureaucrats there is a tendency to treat a 'private' information market with suspicion. Some GIS operators illustratively spoke of some private consultants as the "*piranhas*", who only wanted to make money with expensive software and equipment, trying to absorb cheap public information and never giving good services. Although some (public) universities and NGOs were using GIS for consultancies, they did not want to be working as private for-profit organisations, and perceived their efforts as a contribution to 'the common good'[48]. In reaction to the tendency of privatising information products and the demand for GIS projects, however, the Costa Rican GIS community (state, NGOs and private sector) started to protect its information.

As a solution to data access problems, GIS operators exchanged information in networks of known people (Aguilar et al., 2000). So although in our inventory almost all GIS-operators complained about data exchange, access and quality[49], many also acknowledged that in practice access was not the biggest problem, "…if you knew the right person"[50]. The GIS operators mentioned that they did not have problems exchanging data as long as they could get 'something back', or knew for what purpose the data would be used (Fallas, 1995; Diaz, 1997b). The creation of trust was a key element in these networks, in which being a GIS professional was a factor. The protection of information and the new channels formed to obtain it had created and consolidated networks between technical GIS operators. Belonging to a network was often the most important factor determining access to information, cooperation or common projects. Some exchange networks were based on historical career paths. For example, links between the Tropical Agronomy Research and Education Centre (CATIE), the National Electricity and Telephone Company and the University Centre for Sustainable Development (CIEDES) were based on the fact that all GIS-operators had studied at the CATIE. Personnel from the National University's GIS had been directly involved in the creation of the National Emergency Committee's GIS. Other links were built on experience in common projects, for example, between the Neo-Tropical Foundation and the Ministry of Agriculture or the Ministry of Natural Resources, or linking the Biodiversity Institute with the National University. The organisations in a networks also often cooperated to influence certain national decision-making processes on land-use planning and regulation, policies or state reform.

[48] several GIS operators (G31 & G32, 26-08-1997; NGO12, 28-05-1997; U8, 28-10-1996; U7,13-08-1997).

[49] Sometimes data secrecy was caused by the slow process of correcting data, because of lack of time or experience of the experts who would do the work. The unwillingness had sometimes as much to do with hiding internal training problems and errors, as with monopolising data (G6, 10-10-1997; M4; 18-09-1997).

[50] GIS operator from Autonomous Institute (A9, November 1998)

Besides networks as solutions to problems of data access, the second half of the 1990s saw a new trend. As GIS further developed, problems of data standards and exchange were widely acknowledged. Many GIS laboratories also realised that it was neither cheap nor simple to establish the technology, as was thought by many initial enthusiasts in NGOs and state institutes. This put pressure on state institutes and governments to invest in basic data production. Topographical maps, climate data, soil maps, and maps on land use were too expensive to produce for one individual user and many non-state GIS operators called for the development of standards and maps for public use (Fallas, 1995; Diaz, 1997b; Celis, 1996).

Instead of promoting an 'information market', most GIS operators called for some form of legal regulation of data exchange, and the involvement of state institutions in the elaboration and certification of digital cartographic data (Fallas, 1995). Although the progress of technological capabilities and data production was slow in the state institutions, there seemed to be a general growing acceptance and belief in state intervention in these matters (Diaz, 1997b).

> *Our inventory indicated that some institutes were perceived by many GIS operators as more important for the exchange of information than others. We saw that especially the international Tropical Agronomy Research and Education Centre (CATIE) was popular. Likewise, some of the more established institutes, with many GIS investments, such as the National Electricity and Telephone Company and the National Biodiversity Institute, were highly esteemed. At the same time, the National Geographical Institute and the Ministry of Agriculture and the Ministry of Natural Resources were perceived as important. The popularity of this last group of institutions could only be partly attributed to their information production. It seemed that all GIS operators were interested in these institutions for the formal legal responsibilities of these state GIS laboratories. On the one hand, it was expected that these Ministries would in the end produce nation wide information, and on the other hand, information produced in cooperation with these institutions could be 'officialised'. Also, many GIS operators pressured the state to invest in general base mapping for public use.*

Besides the influence of GIS on the creation of networks and the on the state's responsibility for information production, it also had an impact on institutional change. Institutional change was influenced by digital data, since it had become a strategic asset. We can see this where steps were taken to provide legal protection, or to give information an 'official status'. GIS and large databases legitimised an institutions' role as a pillar in planning because information was a necessity for any planning and regulation process. For many state institutes, the existence of GIS and the fact that they were responsible for 'official data', guaranteed them the role of being "the spider in the planning web". It assigned them a coordinating role. This power position gave rise to a situation where specific cooperation could be sought with some, while excluding others from access to information. This gave state institutes the power to 'boycott', or not, certain projects.

"There is a difference between the ideal and the reality of the state when it comes to promoting the common good. Information is power and will cause exchange problems. Institutes decide for themselves what they think is important information to hand over for policy decisions, and never give what you ask... They will never give any raw data. Information is power, even if you don't use it, as long as you don't hand it out to others... People in Latin America are too legalistic. In Panama, the state institutions did not want to give us the information, so we had to ask a private consultant to produce the data...."[51]. *Private production of information however, also gave rise to secrecy because, for such organisations information is automatically a commercial asset. In the Costa Rican case, a national climate map 1:50,000 and a derived forest capability map were produced with state funds by two NGOs. The project was financed by international donors. The maps were questioned and not accepted as 'official, and the NGOs refused to transfer the raw data to state institutes.*[52]

4.4 Summary

This chapter described the Costa Rican 'GIS boom' during the nineties, under the contradictory tendency of structural adjustment featuring state reduction, and a growing demand for state involvement in environmental issues. In an overview, we illustrated the importance of GIS in many areas of land use planning. Investments in GIS were concentrated in the environmental sector, and some large 'institutional GIS' for urban planning and land registry. By the late 1990s, GIS had become a standard tool for many state and NGO institutes, while universities filled the growing demand for GIS-training. The benefits of all these efforts however, remain to be seen.

To understand the embedding of GIS in the information production landscape of Costa Rica, we went on to analyse the motivations, perceived problems and actual applications of GIS. We saw that many actors, with different interests, were involved in GIS projects. An overview demonstrates how different human agents were involved in both 'push' and 'pull' side of GIS implementation, thereby shaping and re-shaping project goals and expectations. It clearly reveals the shortcomings of considering GIS implementation as a purely technical process of technology transfer. On the basis of our inventory results we analysed the perception of problems of GIS implementation. Through this approach, it has been possible to demonstrate the importance of considering the interaction of a technology with the people working with it on a daily basis. Problems proved to be more than simply technology-related obstacles. Policy problems, training problems and data problems were signalled during the inventory. Although most GIS operators did not explicitly mention the tension between the

[51] World bank official (IFI4, 4-11-1997).

[52] ministerial officials (Ml8, 05-03-2001; M6, 17-04-1997).

final GIS products and applications and the final use of these products by managers and policy makers, this tension was clearly present when analysing the actual use of GIS. This was the next level of analysis for which our inventory was used. The majority of GIS laboratories indicated that their end products were products for policy use. This was also underlined by the importance most GIS operators gave to superior analysis as the most important gain from GIS implementation. Other actual applications of GIS were internal planning and administrative gains. Interestingly, NGO and universities mentioned GIS as an important tool for consultancies and fundraising, illustrating the growing demand for information products on the large donor market for GIS. In contrast with the actual policy goals, literature indicated that analysis was often not used in policy practice, while others stated that the products only influenced the general intellectual climate. We concluded that looking at the products alone does not give us a satisfactory answer as to how and when the products are used. We analysed the impact of GIS's introduction on information production for land use planning. GIS had not radically changed information production. The most important change has been in map making. This raised access issues to data and maps, influenced by the commodification of information and GIS projects. It became more difficult to obtain maps and raw data. Secrecy and a culture of suspicion developed when asking about the actual products. GIS operators reacted by creating new 'institutions' of 'trusted partner networks', but also by demanding more state investments in 'official' information production. This gave state institutions new opportunities to redefine themselves as central "spiders in the land use planning web".

These findings are of crucial importance for understanding the case studies, because they form a large part of the 'technological context' (or the structural properties) for GIS implementation in the three Ministries. In the cases, I will use the findings of this chapter that data, expertise and policy support are crucial resources for human agents involved in actual GIS implementation. The wider context is important not only for understanding the national technological potential and expertise, but also for establishing how the embedding of the technology created new ways of dealing with information in the Costa Rican planning landscape.

5

GIS Implementation in the Ministry of Agriculture

Introduction

In this chapter I will describe the implementation of GIS in the Ministry of Agriculture using the techno-structuration approach explained in Chapter 2. The aim of this first case study is to illustrate the usefulness of this approach, to better understand GIS-implementation as a negotiated process between contending groups within an organisation (in this case the Costa Rican Ministry of Agriculture). In the theory chapter, I argued that to arrive at a better understanding of GIS implementation we have to consider institutional, organisational and political aspects of the implementation process. To do this I introduced techno-structuration as a way of viewing GIS implementation as an interactive process engaging human agents and the structural properties of both GIS-technology and the wider planning context (Figure 5.1).

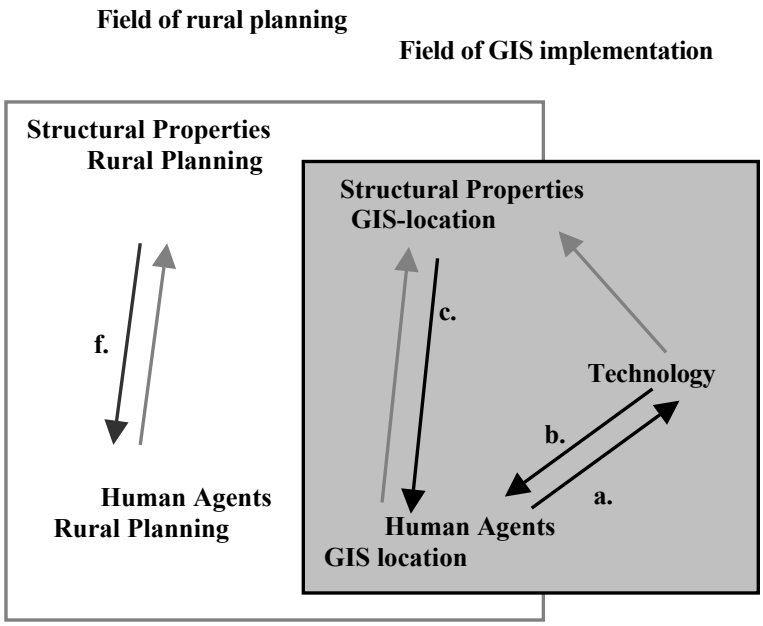

Figure 5.1 Techno-structuration of a GIS in the Ministry of Agriculture

a.& b. GIS implementation as a negotiated process by human agents
c. The influence of data & expertise on GIS implementation
f. The influence of planning and policy priorities on the promotion of projects of GIS implementation
(arrows in grey will be dealt with more extensively in the last chapter)

In order to understand the structural properties and the main human agents involved in GIS implementation in the upcoming case study, I need first to discuss the main issues at stake in

rural planning and the 'planning models' discussed in Costa Rica throughout the 1990s (section 5.1). This provides a background for understanding the relations between human agents or groups involved in GIS implementation and their 'institutional niche' (field of rural planning). In the subsequent section (5.2), I will describe the periodisation of GIS implementation pertinent to this case study, providing the reader with an overview of changes in the institutional embedding of the GIS location during this period.

The last sections describe GIS implementation, divided into two different time periods. In section 5.3, I analyse the initial phase of GIS implementation (1990-1995); implementation between 1995-1998 is discussed in section 5.4. Each period is divided in three sub-sections (Figure 5.1). In the first subsection, I explain the influence of the decisions and reforms in rural planning on the institutional embedding of GIS,[1] and on the resources assigned for GIS projects as part of strategies for rural planning (arrow f). The second sub-section starts with the structural aspects of data and expertise as enabling and limiting factors for human agents of the GIS location (arrow c). The last section looks at how human agents in the GIS location actually implement GIS (arrows a & b). Implementation will be discussed as a reflexive process between human agents and their context. This involves considering the presence of data (c), financial resources (f) and political support, including the 'institutional niche' of the agents of the GIS location. The final section (5.5) summarises the findings.

5.1 'Planning Models' for Rural Planning in the Ministry of Agriculture

During the 1990s, several groups within the Ministry of Agriculture were involved with GIS implementation. This section explains how the 'institutional niche' of these 'human agents involved in GIS implementation' implied a specific vision of how to use GIS in rural planning. In order to understand this institutional niche, I will first describe the different visions. This includes interpretation and use of official policies and proposals for regulations regarding rural land use. In the nineties, these discussions on 'planning models' were strongly influenced by structural adjustment programs and the government's institutional reform policies.

Throughout Costa Rican history, the agricultural sector has been of central importance for the economy. 'Regional planning' was often interpreted as 'rural planning', and without the sector, development would have been inconceivable. Since the seventies, the Ministry of Agriculture was set to become the key player in planning and information systems on soils, land use, and agro-ecological zoning. During the eighties, the Ministry's importance was accentuated by the central role that agricultural export production played as a strategy to

[1] Or, the relation between the structural properties of the field of land use planning with the properties in the field of GIS. implementation (Figure 5.1).

overcome the debt crisis. But in the nineties the Ministry itself ran into trouble. Firstly, the environmental sector gained in importance, took over the Ministry's Forestry Department and openly blamed it for land degradation and deforestation. There was widespread critique of the sector's earlier development practices and what was considered to be the lavish credits given to cattle farmers. Many claimed that such policies had led to erosion and deforestation, turning the country into "one big pasture" (Monge, 1994; Boza, 1992; Figueres, 1992).[2] Secondly, the World Bank criticised the public sector's inefficiency in direct interventions. According to the critique, the public sector had failed to 'transform' poor farmers into commercial agro-export producers (GOCR, 1991a).

World Bank negotiations with the Arias administration in 1989,[3] and with the Calderon government between 1990 to1993, led to a loan proposal of approximately US$41 million,[4] the "*Project for the Adjustment of the Agricultural Sector*" (PASA). Even though in the end PASA was never approved by the Costa Rican National Assembly, it set the agenda for reforming the agricultural sector in the nineties (Gonzalez, 1998b). Therefore the PASA project's content will help us understand what was happening in the sector during that period. PASA contained plans to reform (and reduce) the agricultural sector, while at the same time it would enhance efficiency, through task specialisation, and by only giving direct assistance only to poor farmers (GOCR, 1991a; Raine, 1994). In the World Bank plans, the Minister's Sectoral Secretariat would play a key role in centralising sectoral coordination in the Ministry. Besides reductions in tasks and personnel, PASA also proposed to make investments, such as computers, transport and infrastructure. Investments in a sectoral GIS, amounting to US$ 8,5 million, made the '*Land Use Classification and Soil Erosion Control Program*' one of the largest sub-programs in the PASA loan proposal. This sub-program consisted mainly of information collection (such as soil and land use mapping) and the introduction of a sectoral GIS. The program envisioned generating tools and data to make the government's planning activities 'less political and more neutral and objective' (SEPSA, 1988). The project document saw a lack of information as a major problem for planning. It expected that the introduction of GIS would solve this problem. GIS implementation was described as a straightforward process of technology transfer.

> *The idea was that 'objective data' would lead to the inclusion of environmental factors in policy making "[and] ...support future World Bank agricultural and environmental lending" (GOCR, 1991a). "The physical planning of land, on the basis of the classification of land-use*

[2] That data supporting this discussion were not always unproblematic is documented in Annex 3

[3] Figueres (jr.) was minister of agriculture during the Arias government (1988-1990). He began the negotiations with the World Bank regarding the PASA project. The Calderon government (1990-1994) continued with the project, with some minor changes (GOCR, 1991b). The sector was very surprised when Figueres as presidential candidate refused to support the proposal in the National Assembly when it came to vote in 1994.

[4] The loan was nearly a quarter of the agricultural sector's total yearly budget.

capacity must have the same importance as ... the concept of economic planning, with factors of growth and distribution..." (Vasquez[5], 1991:13). The new land use classification would provide "objective analytical tools to improve and modify the present inadequate allocation of limited resources in Costa Rica" (GOCR, 1991a:84). Large parts of the country were being 'over-used' while other 'under-used' parts still had the potential 'to be intensified' (MAG, 1995; Tosi, 1991; DERSOT, 1994).

Different groups within the Ministry disagreed, however, on how to use the enormous investments in the 'objective tools' of GIS. As we shall see later in this chapter these dynamics meant that 'technology transfer' was not as straightforward an exercise, as could be expected from the mainstream literature on GIS implementation. The different groups had different perspectives and expectations of GIS, and how it should contribute to desired goals of improved rural land-use planning. These different perspectives were directly linked to wider discussions over intervention strategies and the role of the state therein. The three groups involved in GIS implementation in the Ministry of Agriculture were the 'market lobby', 'regulationists' and the 'populists'.

Table 5.1 Proposed Interventions and Expectations of GIS by two Projects and the Planning Office

	Market Proponents (IICA-project)	**Regulationists (LUP Office)**	**Populists (FAO-project)**
Intervention Regions	Regional	National/Regional	Watershed
Governance	Dialogue	Top-down	Participatory
Inter/sectoral	Sectoral	Sectoral	Sectoral
Natural Resources	Global	Public/private	Private
Interventions	Infrastructure/free information	Master plans & Taxes	Technology
GIS Use	GIS for Marketing and Investments	GIS for Official Information	Local GIS for Extension

Proponents of the market as a steering mechanism for rural land use consisted of government (executive) officials and the Minister's Sectoral Secretariat. This group was supported by the private export sector and the World Bank. The market 'planning model' was embodied in the 1997 regional GIS project, executed by the Interamerican Institute for Cooperation in Agriculture (IICA). 'Regulationists' promoted state intervention in land use, through the 'official land-use capability method'. The group was supported by a large section of the state

[5] This preliminary study on land use problems, was financed by the World Bank to legitimate the World Bank project and show the urgency to have it accepted in the National Assembly (interview with the author, 27-05-1997).

bureaucracy and the environmental movement. The group had an important influence on GIS implementation, because the Office for Land Use Planning (the formal location of GIS within the Ministry) was part of this group. The 'populists' were promoting a more participatory approach to land-use planning. This group consisted of the Extension Service of the Ministry, and the specialists of a large FAO project on erosion prevention (that ran from 1992-1998). This project also had a GIS component. The group was supported by small and medium farmers' organisations.

As mentioned above, these three groups involved in GIS were all part of their respective 'institutional niches' and thus linked to more general discussions on rural land use planning. It is therefore useful to explain the link between the proposals of how to use GIS and the discussions on the 'planning models' behind these proposals. These planning models form the 'content' of GIS. In the Ministry of Agriculture, discussions on GIS 'content' dated back to earlier discussion on the use(fulness) of the land-use capability system. These earlier debates were important because the land-use capability system was one of the main applications proposed in the PASA sub-program for GIS implementation (Vasquez, 1991). These discussions also formed the background of the actual practice of GIS implementation, as will be described later in this chapter. While the World Bank and the government placed a lot of emphasis on the new land capability system, assuming its superior objectivity, within the Ministry there was great disagreement on the new classifications. The disagreement was based on two issues: 1) the territorial responsibility that the classifications suggested, and 2) the way in which the capability system should be applied.

The first disagreement went back to a longstanding friction between the Ministry, the Forestry Department and the National Parks Office. The Ministry of Agriculture had always used a classification claiming large areas for extending agriculture, and historically it had defined areas 'not capable for agriculture' as 'potential grasslands'. Environmentalists thought this reflected the 'developmentalist attitude' within the Ministry, which had caused deforestation and land degradation. Instead they wanted explicit classes for 'conservation' and 'forestry'. The overall emphasis on biophysical variables was a common denominator in the discussion. The final compromise, reached by a special committee for the development of 'the official land use capacity system', gave rise to 'flexible' interpretations. Over one third of the national territory was defined as areas for '(semi-)permanent crops', which could include grasslands, forests, but also e.g. coffee and fruits (Box 5.1). It was especially in this contested area that different sectors (agriculture, forestry and conservation) were disagreeing over territorial responsibility. The discussion showed that 'scientific knowledge' was used strategically and did not give a solution for the territorial and sectoral conflicts in land use planning[6].

[6] The problem was (partly) resolved in 1996 when a new Forestry Law was adopted defining areas with actual forest cover as the exclusive responsibility of the Forestry Department (see Chapter 6).

Box 5.1 The Official Land Capability Method

Different state departments all used different classifications, with different outcomes for 'the vocation' of the land (Chapter 3). To overcome the earlier discrepancies regarding methodologies for land capability classifications, the Calderon government (1990-1994) asked a committee with agricultural scientists, conservationists and foresters to "..adapt the capability classification to a unique system that provides a framework for soil and water management practices and projects. Because soil capability and land use recommendations are not consistent across institutions, a farmer can receive conflicting information on how to plan the development and protection of his land" (USAID, 1990:31). The outcome was enforced by presidential decree (GOCR, 1991b. In Table 5.2, the historical classifications for the country are presented. The 'compromise' reached by the intersectoral committee is given in the last column (official classification). The Agricultural Sector Office (SEPSA) pushed for more agriculture, the Forestry Directorate (DGF) wanted more forestry lands, while a conservationist ideal was represented by Vasquez in a study for the World Bank proposal.

Table 5.2 Estimations of Land Use Capacity in % of total territory by different organisations
(elaborated from: Vasquez (1992b) Quesada (1990) & www.mag.go.cr/mapa03.htm)

Source: Year:	Sectoral Secretariat 1988	Forest Office 1988	Worldbank consultant 1991	'Official' 1994
Agriculture **Pasture**	42% 21%		25% 8%	20.5%
(Semi)-Permanent				34.3%
Forestry **Conservation**	16.5% 20.5%	35% 29%	20% 48%	16.2% 28.7%

In the 'official' compromise, the percentage of potential agricultural lands was (just as in the other proposals) more than double the then-reported land under agricultural use, leaving room for intensification. Approximately 16% of forest areas in the compromise were only to be used for limited forest management or natural regeneration. In this area state intervention was intended to prevent degradation and to regulate management practices. Still, one third of the territory was left 'undecided'. The undefined category for (semi-) permanent crops (fruits, coffee, forests or pastures) consisted mostly of areas with steeper slopes and/or shallow soil profiles. With this vague notion there was still room for interpretation for nearly a third of the country! The notion of semi-permanent crops meant that cattle farmers and coffee producers were not threatened by any form of regulation. Only farmers with annual crops on steeper hillsides or shallow soils were classified as 'over-exploiting' their soils. Many farmers on the steeper volcanic soils in the Central Valley and many settlements of small farmers from the Land Titling and Settlement Institute fell under this category.

The disagreements, however, went further than the territorial conflict between the agricultural sector and other sectors. Even within the agricultural sector (and the Ministry) the land capability system gave rise to divergent interpretations. This second issue concerned the different ways in which the land-use capability system was expected to lead to sector policies of land-use planning. The proponents of 'market steering' argued that the state

should not be involved in discussions on the marginal areas. Classification would help direct the state's interventions to 'areas with a high potential production'. Within such areas, it should especially focus on 'poor farmers' who could not make the shift to commercial agriculture without assistance (Vasquez, 1991). The market proponents' logic was that an increase in production would be possible, if the (under-used) grasslands would be engaged differently (Vasquez, 1992b). Zoning studies were to help the government 'take the right measures' to stimulate intensification and prevent further degradation (ibid.). 'Neutral maps' would help the Minister's Sectoral Secretariat to decide in which areas (and crops) investments should be directed.

The logic of relying on market mechanisms to benefit development and nature seemed straightforward to proponents of the market model. Implications, however, were more far-reaching than perceived at first glance. This particular approach to applying the land-use classification meant that many farmers would no longer be eligible for credits or assistance.

> *We see the consequences of this approach in a project from the Interamerican Institute for Cooperation on Agriculture (IICA) that assisted the Ministry in 1996 in its reform process, also adhered to the market strategy. IICA promoted a change from 'planning by activities', to 'strategic planning'. "... in concept, planning in Costa Rica is very good, but in practice, they don't do anything... if you come to a meeting in the regions they say 'we will make three visits to farmers', and in the next meeting they ask if it has happened and write down...'3 visits completed'... If 'fulano de tal' has a problem with chickens... the chicken man goes... It has nothing to do with planning. ...How do you reach that everybody will wear a tie? You can not just put out a decree..[on land use capacity]... We want just to give credit only for one crop, or construct a road up to this point and not any further... without having to make an extensive plan. ...We can not give credit for survival, people have to produce efficiently, and those who cannot survive just have to go to the city and look for something else..."*[7].

The regulationists of the Office for Land Use Planning had a different approach to applying the land use capability system. It favoured 'scientific planning' for the whole country (and not only for high potential areas), under its guidance and responsibility. The main proposal was to link the official land capability system with a tax system. Land that was used too intensively, e.g. pastures on land with the capacity "forests", would be taxed more heavily than land with a 'proper' use. Also land that was "under-used" (such as pastureland on "agricultural areas") would be subject to the same measures, in order to stimulate intensification and prevent land speculation (Monge, 1994). The proponents of the market approach rejected the link between taxes and land capability, because they believed that land owners would have to make their own decisions on land use unless there were compelling public interest issues at stake (Lutz & Daly, 1991). Legal advisors and politicians pointed to the difficulty of enforcing measures on 'under-used lands', because "under-use" would not cause a direct environmental threat to the public good (Chavez, et al., 1995; FAO, 1996a).

[7] IICA team member (IICA meeting notes, 18-08-97 & 18-09-97).

Besides the tax system, the Office for Land Use Planning claimed that the land use capability method should be used for regulating all sectoral state intervention, through a 'National Plan for Land Use'. This National Plan would serve as a binding instrument for the sector institutions, and it would limit actions to assigned areas. With these proposals, the Office aspired to coordinate the sector, and it competed for power with the Sectoral Secretariat of the Ministry. It was argued that by functioning further away from the executive, a 'technocratic and neutral' Office also could prevent government corruption [8].

The populists of the Extension Service of the Ministry, and large FAO project, finally, did not agree with the interpretation of using the 'land use capability method' to limit the assignment of funds for high productive areas. In defence of small and medium producers, they claimed that farmers who urgently needed public assistance were mostly farming on poorer soils. Moreover, they claimed that the land use capability system was not relevant and maybe even useless. The FAO project expressed this idea most forcefully. It argued that once the land was occupied, it was not economically interesting, and it was socially unacceptable to 'reorganise' that occupation (FAO, 1996a). According to the FAO-project, even if the land use was sub-optimal for its capacity, it would be an illusion to think that the state could prohibit certain uses.[9] The Extension Service and the FAO-project saw the introduction of new crops or technological improvements as the most promising solution to prevent degradation and stimulate production. Populists were not against zoning studies indicating alternative crop options, but placed more emphasis on projects and programs that supported local and regional initiatives of existing production systems (including basic grains) (Roman, 1997b).

The approaches, and proposals for land use planning detailed above, prepare us to now look at how different ‘planning models’ demand different information products and a different institutional embedding of GIS (Table 5.1). The table’s bottom row summarises the different groups’ expectations for GIS use. Firstly, the Sectoral Secretariat and the Interamerican Institute for Cooperation of Agriculture wanted to stimulate infrastructure and credit in high potential areas of the different regions, using its comparative advantages. GIS was to be used to find new competitive crops for certain areas and to help investors find market niches for certain production. Information on high potential areas was to be coupled with market information for crops. GIS information was also to be accessible and free for all farmers and potential investors. Secondly, the Office for Land Use Planning wanted a GIS that would contain nation-wide standard data for the purpose of the 'official land capability system'. GIS

[8] One widely quoted example was the Ministerial support for an orange production project in the Northern Zone, in sub-optimal agro-ecological areas, benefiting factories owned by relatives of people high up in the ministry (M48, 15-02-1996; M38, November 1997; TERRA meeting notes, 18-03-1996; M21, 20-10-1997).

[9] Interview with high-level government official (M4, 16-03-00).

should also be used for the elaboration of Master Plans, which would guide sectoral activities. GIS was perceived as a large database, to use old methods more efficiently. Thirdly, the Extension Service and the FAO Erosion Project wanted to plan in watersheds with participatory methods to develop technology. This meant that if a GIS would be used at all, it should contain a wide variety of social, economic and biophysical data at the farm level, and give indications on actual land use. GIS was also seen as useful for defining 'recommendation areas', for a tested technological innovation, with similar agro-ecological characteristics as the 'test'-area. In other words GIS was perceived as a data-intensive tool, to answer specific analytical research questions about locally based interventions.

While we have seen how different visions of GIS implementation have been linked to wider divergent discussions on land use, it should also be noted that to a certain extent, these visions were not entirely exclusive of each other. A national database for land-use capacity and crop zoning was also strategic for marketing information. A local level GIS application could use a detailed soil map as proposed in the PASA sub-program and by the Office for Land Use Planning, while the World Bank's marketing strategy was not incompatible with the FAO's claims against the top-down planning approach of the Office for Land Use Planning.

But rather than seize the opportunity to benefit mutually from commonalties, the differences in planning visions were magnified by the institutional reforms and power struggles in the agricultural sector during the 1990s. With support of the Minister, the Office for Land Use Planning was officially created in 1991, to take over the role of coordinating land use planning for the sector. It also was to serve as the official national counterpart in the World Bank's sub-program, the Land Use Classification and Soil Erosion Program. The new Office consisted of personnel from the crop-zoning program of the Sectoral Secretariat, as well as personnel from the Soil Division and the Erosion Service (including the FAO project). The merger between the field-oriented Erosion Service with the other more planning-oriented groups made sense on paper, because the World Bank program contained (besides a planning and GIS component) a large erosion prevention component. The FAO program also had a GIS component, and it was expected that it would also contribute to implementing a GIS within the Ministry. But looking at the difficulties of GIS implementation (as we will see in the upcoming pages) and the poor cooperation between the different groups in the new department, something would seem to have gone wrong. After two years, personnel of the new Office accused each other of secrecy, obstruction and even corruption.

> *" Within the Ministry some people were totally focused on the land use capacity decree that just had been approved. ...they just wanted to create an important institute for themselves, and wanted to give jobs to their friends..". Further the new Department was referred to as*

"...just a group of beer drinking friends, who liked to travel at our [FAO] expense.."[10]*. In the Office for Land Use Planning, the proponents of the capacity system mentioned that "..a team that stubbornly stays just in one part of the concepts of land evaluation [only field oriented] only wastes its time in defending its own institutional niche [the importance of extension activities]...and therefore nothing gets done".*[11]

The problems mentioned in the comments above demand a more profound analysis, because even though in principle the GIS applications were not totally exclusive, the clash between the groups suggested that the different visions on planning and GIS went beyond mere planning philosophies. This points to the importance of political and institutional aspects of GIS implementation. Before turning to the actual dynamics of GIS implementation, I will first shortly introduce the changes in the institutional embedding of GIS.

5.2 Organisational embedding of GIS implementation

In this brief section I will give an overview of the institutional shift during the nineties. This serves as an introduction to the actual dynamics of GIS implementation in the Ministry of Agriculture. Because organisational shifts were key for marking the two periods, this section assists the reader to understand the upcoming sections on actual GIS implementation. We will look at two periods: the period of GIS's 'early development' featuring many initial problems (1990-1995), and the period of 'stabilisation and application' (1995-1998).

Each time period has been divided into three subsections. In the first subsection, I explain the choices that governments made during the nineties to support or implement certain GIS projects for land use planning. This involves exploring the influence of the political and institutional shifts in rural planning on the institutional embedding of the location of GIS implementation, and on the resources that enable human agents to promote their vision of GIS implementation. In the second subsection of each period, we will narrow the focus to consider the requirements for data and expertise of various government projects. The actual presence of data and expertise forms the 'technical resource' of the GIS location. Together with the influence of the institutional properties of land-use planning on the institutional organisation of the GIS location, these 'technical prerequisites' form the institutional properties of GIS. These properties enable and limit the actions of the human agents of GIS implementation. In the third subsection, I describe the different expectations and choices that lay behind the actual 'models' implemented during the two time periods. This section will show how GIS implementation has to be understood as a process of political choice.

[10] ministerial professional (M53, 28-01-2001)

[11] ministerial professional (M19, 9-3-2000)

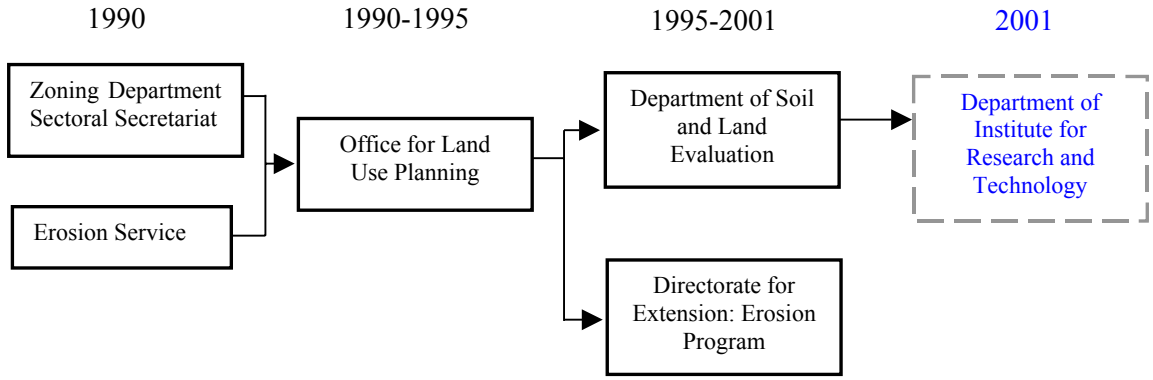

Figure 5.2 Changes of the Institutional Embedding of the GIS

The periods 1990-1995 and 1995-1998 do not coincide with the political shifts (90-94 and 94-98). The reason for this particular division is that before 1995, the GIS was an important part of the Office of Land Use Planning. The Office was abolished after this date and the personnel, with the GIS, were transferred to the Office for Research. The Erosion Service, with its FAO project, was transferred to the Directorate for Extension. Before 1995, the Calderon government (1990-1994) supported the Office as coordinator for rural planning, and during its first year, the Figueres government (1994-1998) was undecided as to the role that the Office should play in rural planning. After 1995 we can identify a shift in planning visions. The administration created a powerful intersectoral committee for land use planning (TERRA), which would take over planning responsibilities from all the sectors, including from the Office for Land Use Planning. While the Office officially disappeared after 1995, its personnel and GIS were still part of the Ministry, under a different name. It is important therefore to note that when I refer to 'the GIS Department', I mean the new location of GIS and the personnel of the (former) Land Use Planning Office.

5.3 Early GIS Developments (1990-1995)

5.3.1 Government support for GIS: Projects and Policies

This section will illustrate the influence of the political shifts on institutional reforms and projects that supported GIS projects in the Ministry of Agriculture. It is important to look quickly at the most important political shifts of the period. As we mentioned in the history chapter, the Calderon government (1990-1994) dismantled the Regional Planning System of the Ministry of Planning. It also formulated plans to decentralise many responsibilities to municipal governments, and under pressure from the World Bank. Within the agricultural sector, the government stimulated task specialisation of different sectoral institutes[12]. The

[12] All extensionists working for the Marketing Board and for the Land Reform Institute, for example, had to be transferred to the Directorate for Extension (GOCR, 1991a).

coordination of all sectoral projects and programs would be done by the Office of Land Use Planning (DIPLUT), created by presidential decree. This Office also would coordinate land use planning activities of the sector with other sectors and municipalities.

The Office was given the responsibility of developing a GIS for the sector. The first computers and GIS-software were donated in 1989, with left-over funds from a terminating FAO project on erosion prevention, financed by the Italian government[13]. The input was the soil map on a 1:200,000 scale (Acon & Associados, 1991). The GIS was not used, however, up to 1992. At the time, the Office was not well established and needed support for training and data collection, to improve the use of the new technology. With the negotiations and the formulation of the World Bank proposal (PASA), between 1990-1993, the GIS was put back on the agenda. The sub-program on "land use classification and soil erosion" was to involve the creation of a detailed soil map for the whole country, as well as studies on climate and land use change. GIS implementation and training were to be part of the project.

The Office was still vulnerable to future political shifts that could threaten its existence, if the next president would not acknowledge the decree. For this reason the Calderon administration preventatively formulated the "*The Land Use, Conservation and Management-Law*" as a proposal for legislation that would further safeguard the office (GOCR, 1991b, 1994a). One of its explicit goals was: " ...the consolidation of a specialised institution with wide ranging powers in matters of land use, management and soil conservation, with a *permanent character*" ([italics mine] GOCR, 1991b & 1994a). The law was to give the Office the task of presiding over a 'National Committee for Land Use'. According the proposal in the law, the Office would formulate regional land use plans, coordinate with other sectors (for e.g., road building), and assist all Municipalities with regulation plans for rural areas. The Office would also be responsible for GIS and soil mapping and the supervision of PASA's 'land use zoning program' (GOCR, 1994a). As reflected in the law proposals, and the land-use capacity decree described above, GIS and information would become of strategic importance to maintain influence in rural planning.

Information and modern technology played an important role around the negotiations of the World Bank project (PASA). The Calderon government claimed that GIS and information were urgently needed, to find ways to improve Costa Rican land use. These claims were actively used by the government to gain support for the entire World Bank project[14]. For the Office, these claims offered a way to convince policy makers of the necessity for investing in GIS. In the run up to the final debate over the World Bank project in the National Assembly (scheduled for 1994), the Calderon government tried to come up with a showcase to prove

[13] The general historical facts are based on several interviews with people involved with GIS developments in the Ministry (M3, M48, G12, M50, M49, G10, G11, M38).

[14] government consultant (G41, 27-05-97)

the necessity and urgency of the investments. The administration, therefore, supported the Office by financing a project for the 1:50,000 soil mapping of the Central Pacific Region. The study included a combination of land-capability classification and zoning following social and infrastructural factors (MAG, 1994). The results were expected to help in planning the sectoral activities, but also to show that current land use needed to be improved dramatically. The project was executed by an environmental NGO, with assistance of the Land Use Planning Office. The final results were not available in time for the discussion in the National Assembly, because the Office for Land Use Planning did not have the capacity (nor money) to transform the final maps into a GIS. As mentioned earlier, the World Bank project was rejected.

Table 5.3 GIS Projects and Products (1990-1995)

Year	Project name	Main agents in project	Expected results	Status
1991	'*Land Use Classification and Soil Erosion Control Program*'	Office LUP	Soil maps and Land Use maps 1:50,000	Not executed
1992	GIS component FAO project	FAO, Office for LUP	Recommendation areas. Data 1:200,000	Executed
1993	Central Pacific Crop Zoning	Tropical Science Centre	Soil map and Climate map 1:50,000	Executed in paper formats
1994	Green House Gas Inventory'	Office LUP, IMN, IGN	1994-Landuse map 1:200,000	Executed

Without the financial support of the World Bank, and with the Ministry itself in a financial crisis, the new Office had to look for other funds. The most important project for financing GIS development, during the Calderon period was an FAO project on erosion control, financed by the Dutch government. The total funds amounted to around US$4.7 million (Dutch Embassy, 1997). A team of 11 international specialists was hired for the 'innovative erosion control project' (FAO, 1994). The 'field approach' was innovative for the participatory diagnosis of problems and for the introduction of simple erosion control measures. The work was organised through the former Erosion Service working closely with the regional and local offices of the Extension Service of the Ministry (FAO, 1994). Because the Erosion Service was merged into the Office for Land Use Planning, however, it was this newly created office that was the official counterpart of the FAO project. The FAO-project officially started in the autumn of 1992. GIS was included in the FAO project because of pressure from the bureaucracy to compensate for the delays with the World Bank project. The FAO project included one international GIS specialist who would make GIS useful for the FAO project, but would also help to set up the GIS capabilities of the Office for Land

Use Planning. As we will see later, the different planning philosophies of the FAO project and the Planning Office led to frictions and conflicts over intervention policies and to the stagnation of GIS implementation.

Only in 1994, after the World Bank project PASA had been rejected by the National Assembly, did the Office for Land Use Planning receive funding explicitly aimed at GIS development. This was through a project for 'the Green House Gas Inventory' from the Global Environmental Fund (GEF). It was a last attempt by the Calderon administration (1990-1994) to support the Office for Land Use Planning. The project would fund the elaboration of a 1994 land use map. The final goal for the Office was to overlay the actual land use map with a land capability map, indicating areas of conflicting land use. The Office could show the urgency of government intervention (and hence reason for its existence) in stimulating land-use intensification. The Office hoped that results of the Green House Gas project would create support for the proposal of the *"Land Use, Conservation and Management Law*" and that the results would convince the incoming Figueres government (1994-1998) of the need for its existence.

These examples of projects during the Calderon period illustrate how GIS implementation projects and its (expected) products were influenced by the broader proposals for safeguarding the Office's position and consolidating the regulationist planning philosophy. The Planning Office proved it had substantial leverage in the negotiations with major donors, since its GIS-wish stayed on the agenda. Different groups expected different outcomes from the GIS projects, however, as we discussed in the first section of this chapter. Within the Ministry (and even within the Office) there was disagreement on how to use the GIS. There were divergent expectations if GIS should be used for top-down planning, or for extension purposes, while donors often expected GIS for guiding investments of the sector (Table 5.1).

As suggested earlier, the actual implementation was not only dependent on the available project money and institutional support. We have already mentioned that two other factors have to be taken into account. The first is how the expertise and data enabled or limited in building a GIS following the image of proposed projects. The second was how human agents with different visions on planning were able to promote their version of GIS on the work floor. We will first turn to the expertise and data aspects of GIS implementation.

5.3.2 Expertise and data aspects of GIS implementation (1990-1995)

Because the Ministry of Agriculture was one of the first to have a GIS (in 1989) expectations were high. The early progress, however, was largely time wasted, when the key persons left the Ministry during the early nineties. The old GIS data was saved, in 1992, more or less 'by accident', when an MSc student, who worked for the FAO project, managed to revive the GIS. This led to renewed attention for the GIS and a revaluation of its data collection.

In 1992 a Dutch MSc student revived the computers with its GIS database during a 'practical period' for his studies. He recalls that "... the computer was gathering dust in a dark cubicle ... and there was no money for training or development. The floppy with the network software was gone, together with the person who knew about it... I revived the computer...and later changed the database into an accessible format. Most applications were map making, because the knowledge of Arcinfo [a software with more analytical possibilities] was lacking..". About the database he adds:" the Soil Database was never extended; profiles from an FAO project and other published profiles were never included. During that period GIS-data was surrounded with a veil of secrecy and it was forbidden to exchange any data...the Database thus was only used by some people in the MAG, [and these people later stopped working in the Ministry] ...probably its existence is not known widely outside the institution..."[15].

The renewed interest in the GIS was primarily due to the promise of its potential use, and not by the actual results of the early unsatisfactory experience. General expectations that GIS would help to use information more efficiently led to its adoption into the World Bank 'GIS-sub program'. Because the World Bank project was delayed, at first, most investments in GIS were made by the FAO project. The FAO's most important contribution to GIS implementation was the hiring of an international GIS specialist. This person was the same (now former) student who had revived the computers earlier on in 1992. He worked in the FAO project from late 1993 until the beginning of 1996. While the FAO specialist developed a GIS, the personnel from the Office for Land Use Planning first received training. The Office slowly absorbed the data and products produced by the FAO GIS specialist, and the Office was to develop its own facilities to full capacity once the World Bank project started.

The GIS specialist provided some basic training for the personnel of the Office for Land Use Planning. Later, six people of the Office for Land Use Planning received further training with FAO funds at the National Autonomous University (FAO, 1993). Four specialists from the Office were trained abroad. Without any data, the first task of the FAO GIS-specialist was collecting and digitising information that before existed only on paper. For this purpose he arranged official agreements with the National Geographical Institute and the Centre for Sustainable Development of the University of Costa Rica to access data and for the digitisation process of an 'official' topographical base maps on a 1:200,000 scale. Also basic information on climate and soils, were digitised. In a national inventory of GIS developments in 1994, undertaken by the National Biodiversity Institute, this database within the Ministry of Agriculture was evaluated as one of the most valuable in the country (Consultora Quatro, 1994). The (very general 1:200,000) data was shared with the Office for Land Use Planning that used it later for an overlay on the National Land Use Map, to elaborate a land capability map.

[15] Interview with GIS specialist from FAO project.

While the description of cooperation would seem straightforward, the relationships between the organisations and the training process were not smooth. Firstly, training of the personnel of the Office for Land Use Planning was slower than expected. The personnel were just starting the training in GIS use when the FAO-GIS had elaborated a substantial database. FAO was working already on new applications while the Office only understood the principles of simple overlay. This gave the FAO-specialist the upper hand in developing his ideas independently. Only in 1994 was the Office for Land Use Planning reinforced with a new GIS specialist. As an outsider in the Office, he worked on developing 'uses' and 'models' for GIS, together with the FAO-specialist. This led to conflicts in the Office and led to his early departure. Secondly, in 1994, after their first training at the National University, the personnel were busy with the digitisation of the study of the Central Pacific Region and the Project for the Green House Gas Inventory. As mentioned earlier, this project received priority, given the strategic nature of information and its role in convincing the incoming government the importance of the Planning Office. In other words the priority was 'data gathering for self-preservation'. Thirdly, there were tensions surrounding money and the work priorities. FAO-personnel accused the Land Use Planning Office of trying to "get the FAO-money for their own zoning projects.. [or even]...personal gain. We first gave them training and hired their services for soil studies, but then they started to see the FAO project as their 'current account'..."[16]. FAO personnel also did not agree with the Office's focus 'paper plans, maps and stipulations'. With more maps, no innovations would ever be implemented[17].

> *"[T]heir land use capacity method is useless [but it is also] the methods and work ethic that makes the difference... the people at the Office were very conservative and some even 'vagabundos' [slackers] ...most did not want to learn new things.."*[18]

Throughout 1994, relations were 'at an all time low' and there was hardly any communication between the FAO project and the personnel of the Office.[19] Although the Office for Land Use Planning was the official counterpart of the FAO project the difficulties between the two organisations resulted in a situation where an 'FAO-GIS' was built independently, beside the GIS of the Land Use Planning Office. Both GIS projects envisioned different uses of information and planning models, as will be discussed below.

[16] high level ministerial official (M21, M22).

[17] high level government advisor (M4 ,16-03- 2000)

[18] former ministerial official (M53, 28-02-2001).

[19] government official (M10, 22-02-2001)

5.3.3 Actual GIS implementation (1990-1995)

This section describes the actual practice of GIS implementation on the work floor, during the first phase of GIS development. We will see how different human agents (with their own 'institutionalised' planning philosophy) use government support, projects, money, data and available expertise to promote their 'model' of planning in GIS. This will illustrate the importance of the technostructuration approach for understanding the choices made during implementation.

The first group promoting GIS was the personnel of the Office for Land Use Planning. As we saw in section 6.1, the Office promoted a regulationist version of land use planning. The development of its GIS, however, was also in line with the vision of the market proponents as promoted for example through the World Bank project PASA. The activities of data collection, training and GIS building were congruent with both a market approach to GIS (potential crop zoning) and GIS use for the 'official' land use capability system. For the Office, the information and 'the scientific tools' guaranteed their role in regional planning and sectoral investment projects (DERSOT, 1994). The detailed soil information was also important for applying the land use capacity method at a Municipal level for local regulation plans. Control over soil information and the computer technology to quickly apply it for a nation-wide study on for example, oranges, gave the Office a strategic position. Its idea of GIS was thus especially a database of soil information (and other information needed) to automatically apply the 'official land capability method', and zoning of potential crop production.

The second group had a more populist posture with regards to GIS implementation. This group consisted of the FAO project and the Erosion Service personnel. This group expected different things from a GIS. With their field-oriented approach the FAO project was more interested in actual crop production, its limitations and areas for improvement. The first application was the use of GIS for the mapping of recommendation areas (areas with similar agro-ecological conditions as in the pilot areas) in which the participatory technological innovations could also be tested (FAO, 1996a). Essentially we can refer to this as a planning philosophy surrounding local needs, in which the GIS could be used for generalising local experiences. The second application was the use of GIS for a Land Evaluation method, ALES. ALES is an expert system in which simple qualitative and quantitative data can be combined to estimate crop production and economic costs and benefits. An example of the ALES application was the calculation of the profitability of water melon for one of the FAO-pilot areas. The study suggested that on poor soils, classified through the 'official land capability method' as 'non-agricultural soils', it was still profitable to grow watermelon, without harm to the environment (Hoogenboom, et al.2000; Laake & León, 1995). With this study, the FAO project challenged the land-use capability method of the Ministry.

In an attempt to merge the philosophies of both groups, the GIS specialist of the FAO worked together with the new GIS specialist in the Office for Land Use Planning, to prepare a report with suggestions on GIS use in the Ministry. The report suggested stimulating the introduction of GIS in the Regional Offices of the Ministry for the application of ALES (Laake & León, 1995). They proposed to implement ALES within the Ministry on different levels to enhance 'planning'. At the National Level, officials would set the standards, translate the Ministry's goals into models (e.g. which crops should be chosen as alternatives) and make the methodology work. In the regions, the regional directors could use the methodology for project planning (for example, in which (sub)area is it profitable to produce a national priority crop), and locally, extensionists could try out and visualise the consequences of existing production systems, new varieties, technology, and changes in price etc, on profitability of land use (Laake & León, 1995). Although the method left space for the planning approach of the Office for Land Use Planning, the focus would be on the field (or maybe the regional) level. The Office would only keep training tasks, and lose the responsibility of 'defining scientifically' what had to grow where. According to this vision, GIS would become a tool for extension rather than for planning. A report was written by the new person in the Land Use Planning Office. He openly promoted these ideas, but according to a key informant was "..not very popular in the Office for Land Use Planning. …He left after one year to do a Masters degree in the USA, never to return to the Ministry"[20]. The Office of Land Use Planning was not receptive to these new ideas. It resisted change or new dimensions that threatened its regulationist approach and centralised power.

Within the rest of the Ministry of Agriculture, the report was received with mixed feelings. The application of ALES generated a debate among government officials about the utility of the official land use capability approach (Hoogenboom, et al., 2000). The Office for Land Use Planning succeeded in restricting the final report 'for internal use only', and to their satisfaction, it was not widely known. During this first period (1990-1995), ALES's regional applications were seen as a threat to centralised information control, important for survival of the Office for Land Use Planning. But ALES also threatened the 'authority and validity' of the official land use capability system. As the FAO suggested, with the ALES study on water melon, the land-use capability system was riddled with flaws and errors (Box 5.1). Here we see that the GIS had itself taken on a status greater than justified by its actual usefulness. In this sense, the perceptions surrounding the information technology were more valid than the systems themselves.

> *"..The capacity system excludes the possibility that different crops have different effects on the soil quality, and doesn't consider socio-economic variables, nor the experience of the farmer..."*[21]*. Still, "[the ALES report] was a drop in the dessert,[and] ..it was its time too far*

[20] ex-ministerial professional (G10, 22-02-2001)

[21] ministerial professional (M53, 28-01-2001)

ahead"[22]*. "Within the Ministry, some people were totally focused on the land use capacity decree that just had been approved. This capacity system was linked to particular interests...of especially foresters and agronomists.." [because they make a living off of applying the 'official system'].* [23]

5.4 GIS adoption and stabilisation (1995-1998)

5.4.1 GIS projects and institutional support

We have just seen how during the first period of the nineties, the GIS of the Office for Land Use Planning was supported by the Calderon government. It focused on the development of a National Soil Database. In 1995 policy dynamics shifted. This second period was full of uncertainty for the Ministry of Agriculture as well as for the GIS-Department. The Figueres government (1994-1998) had substantially cut back on personnel during the first year in office. By 1995 the Minister of Agriculture responsible for the reduction was replaced by a more populist Minister. Under the second Minister, the Ministry of Agriculture was redirected towards a 'hands on approach' to farmers and the agricultural sector. This meant that rather than use agro-ecological zoning as a means of establishing project priorities, 'dialogue' was promoted with farmers and the agricultural sector (SEPSA, 1996). In contrast to the Calderon administration, the Figueres government tried to stimulate integration of all sectoral institutes to make Regional Service Centres. The Regional Offices of the Ministry would help farmers with services of information on marketing and agro-industry and extension, based on the priority projects mentioned above. We can consider this to be a populist tendency. As part of the policies, the Office for Land Use Planning was abolished in 1995, and the Erosion Service, together with the FAO project, went to the Directorate for Extension, while the Soil and Land Evaluation personnel (with their GIS) were transferred to the Research Office (Figure 5.2).

The government's overall planning and zoning responsibilities were re-directed to, what previously, has been mentioned as the powerful Presidential Committee for Intersectoral Land Use Planning (TERRA). This meant that the Ministry's Office for Land Use Planning, including its GIS, was redundant (MIRENEM et al., 1995b). For this reason, during these first years of the Figueres administration, the GIS-department did not receive any new investments. The Soil and Land Evaluation Department followed an isolationist strategy to survive. The (then) Department for Soil Science and Land and worked through small projects on its own GIS skills.

[22] ex-ministerial officials (M4 , 16-03-2000; M19, 9-03-2000)

[23] ministerial professional (M53, 28-01-2001)

After the reorganisation, the personnel of the former Office for Land Use Planning was conscious that "..they were viewed as an isolated group within the Ministry. But it was not something totally involuntary, because it permitted them to escape from the pressures and political changes within the ministry '...it was a survival strategy, that has permitted us to work as a group, and made it possible to advance our projects, and stimulated our technical and scientific progress…'" (Ministerial Official, quoted in Mera, 1998b:14). The new director of the GIS Department explained: "We don't expect money from the Ministry for investments in computers and software, because there is no money... If we want to invest we have to do it through cooperation in projects with NGOs"[24].

Table 5.4 GIS Projects and Products (1995-1998)

Year	Project name	Main agents in project	Expected results	Status
1995	Creation of Committee for Intersectoral Land Use Planning (decree)	Government/ Ministry of Planning	National GIS, Intersectoral maps, topographical maps 1:25,000	Partially executed
1997	Soil mapping of Costa Rica	GIS department Ministry	Soil maps 1:50,000	Executed
1997	INFOAGRO	IICA, SEPSA	Regional GIS and free information access	Executed without GIS component

In the second half of 1996, the second Minister of Agriculture resigned and was replaced by a more market-oriented person. A more market-oriented group (supported by members of the Sectoral Secretariat) became more influential within the Ministry, calling for 'competitive projects' to prepare Costa Rican agriculture for the world market. Instead of dialogues, more attention was paid to efficient spending of public funds, towards areas of high potential. The Ministry asked the Interamerican Institute for Cooperation in Agriculture (IICA) to assist with the integration of different sectoral institutes' activities into the new Regional Sectoral Offices.

All these reorganisations threatened both former members of the Office for Land Use Planning; the Erosion Service as well as the Soil and Land Evaluation Department. It is here that we see how organisational and institutional reforms led to specific survival strategies, which will later return in the actual decisions and choices of how GIS was eventually implemented. The Erosion Service was mostly focused on poor and degraded areas, which in future would not be the target group of the Ministry of Agriculture. The Soil and Land

[24] director of GIS-department 4-06-97.

Evaluation Department was threatened by the plans to decentralise planning and information, while making one information centre for intersectoral information under the new presidential committee.

The FAO project reacted to the reforms with a proposal to make 'conservationist agriculture' a new task of the Ministry of Agriculture. The second and third Ministers of Agriculture both supported the idea of conservationist agriculture. This could be explained in part by the 'friendly' relations between FAO and the Ministers, but the 'conservationist agriculture' was also of key importance to keep sectoral responsibility over marginal areas. The FAO project also took up the task of reformulating the *Land Use and Soil Conservation and Management Law*, making it more in line with participatory methods of land use planning.

> *"...to defend ourselves against the' environmental imperialism' we came up with the concept of 'conservationist agriculture' ...with that terminology we can compete with others for sustainable development money"*[25]*. "Luckily, we had lots of influence with the Minister of Agriculture, because he was the brother of the national director [of the FAO program], and because an FAO project implied money.."*[26].

The GIS-Department had a different strategy. It managed to convince the third Minister of Agriculture, of the importance of soil information, for both a market strategy for rural planning, as well as for keeping sectoral influence in rural planning matters. Early 1997, the Minister decided to invest just over US$1 million, in new soil maps (1:50,000). The soil maps would guarantee that the agricultural sector would keep a strategic information product, giving it an important resource in the re-organisation of land use planning. One important reason for the renewed support was the sectoral resistance against the presidential committee for land use planning that was supposed to take over all coordination responsibilities.[27]

> *"...it is clear that we need some form of "ordenamiento territorial". But in Costa Rica integral planning doesn't work because different Ministries don't work together. Therefore you first have to know what you want to change, ...soccer, poverty, or what... for us land use is the most important, therefore we have to know something about land use and soils. The Ministry of Environment and Energy might say 'we are responsible for land use planning', but they should only be responsible for the protected areas, and those areas are*

[25] high-level government consultant (Go32, 18-09-1997).

[26] high-level government advisor (Go, 2001).

[27] Another factor contributing to the Minister's decision on the soil mapping project was that, even though the committee first promised to elaborate soil maps, the committee later failed to deliver any information products and financial support was finally withdrawn (Chapter 7). New soil maps remained an illusion. Even supporters of the presidential committee arrived to the conclusion that giving the mapping responsibility to the Department was the fastest way to generate this information.

already regulated [ordenado], they have the category of protected areas "[28]*. "..[O]rdenamiento territorial is something easy, a group of students can do it. The difficulty lays in the execution. The Ministry of Environment and Energy is already overloaded with tasks, and they don't have any personnel in the field. The Ministry of Agriculture is the only Ministry with some outreach, we have people in every corner of the country"*[29].

The Department of Soil Science and Land Evaluation also (reluctantly) teamed up with the FAO project group to rewrite the earlier legislation proposals from the Office for Land Use Planning, in order to make the Ministry officially responsible for land-use planning in degraded areas. FAO compromised for 'strategic reasons' by including the capacity system[30]. The law was approved in 1998, 'because of good relations between the FAO project and the subsequent Ministers of Agriculture'.

Once the decision to finance the soil maps was taken (in January 1997), the Minister's Sectoral Secretariat, and the IICA formulated a project to stimulate GIS implementation in Regional Offices (Box 5.2). The GIS project was an important component of a larger reform program: the 'INFOAGRO' program. This larger program focused on the use of information technology and internet. The use of information would create 'a new dynamic' that would change the planning approach that began with dialogues with farmers, into 'something less political, based on facts'[31]. The IICA project would build a national digital network. The 'INFOAGRO' network was also meant for farmers and investors, to find information on markets, prices and production. Through the GIS project, IICA wanted to include the use of soil information and zoning studies into the network, as freely available resources. It was hoped that this would improve the planning cycles of the Regional Offices. This project reflected the government's intention to stimulate decentralisation and a market approach to land use change. It is important to emphasise that the IICA-GIS component was to have deep consequences for how to deal with digital information. In contrast with the dominant discussions in the GIS community in Costa Rica (Chapter 4), IICA wanted to make digital GIS information freely available.

[28] high-level government consultant (G41, 27-05-1997).

[29] high-level government consultant (Go51, 25-03-1996).

[30] Once the capacity system (which was only approved by presidential decree) would be included in a law, it could not so easily be neglected. It would give the Ministry of Agriculture the responsibility over land use issues in the entire national territory (several ministerial officials: M4, 16-03-2000; M21, 04-03-2001; M22, 21-03-2001)

[31] The Ministry was financing projects for 'Productive Restructuring' that would prepare farmers to produce competitively for an open world market. Sectoral Secretariat Representative: "The productive restructuring project is now only managed by the board [of ministerial directors and farmers organisations], it is too political....they don't take technical arguments into consideration". IICA representative: "With our project this will change." (Meeting notes IICA project 18-08-97).

Box 5.2 the four Regional GIS uses envisioned by the IICA project

1 Georeferencing projects and credits

The Regional Offices were to have information on credits, projects, farmers-organisations, agro-industry and computer locations. This information was expected to help with formulation, administration and evaluation of projects and credits in the regions, but it was also to help the Ministry and Sectoral Secretariat in administrative control of the decentralised projects. "With these forms you can evaluate if everything is in its place...you can for example see if credit is very concentrated in one area, but more importantly, a GIS will also help to decide if you should give credit or not in this agro-ecological zone..." (IICA notes, 23-09-97). "We can not give credit just for survival, people have to produce efficiently, and those who cannot survive jut have to go to the city to look for something else" (IICA notes, 18-08-97).

2. Linking technologies to Agro-ecological zones

IDETEC is a database developed by the CATIE and the IICA, for an inventory of agricultural technologies (Saravia, A. & F. Durán, 1996). The actual database was based on expert knowledge, but the Ministry could add technological options per crop and environment. IDETEC used five environmental variables: rainfall, altitude, fertility, slope and type of farmer. "The crop in its environment is determining the technology" (IICA notes, 18-09-97). "The big advantage of IDETEC over the land use capacity method is that we have 32 different technological solutions for different environments and with the capacity method you only get one outcome. With IDETEC we get recommendations on plant distances, inputs..." (IICA notes, 26-08-97). The idea was that extensionists in regional offices would be able to give better advice on technology and share experience with others: "An extensionist now has too much responsibility to just advice on a technology from a distance. What he needs are instruments to help him. The Ministry now has nothing. People have the idea that if they know something they won't tell it to anybody, because otherwise they make themselves dispensable. We need to put the information in a computer to help each other. When a farmer comes with a question on credit or technology, the extensionist can use IDETEC. ...Of course the extensionist will not be replaced by the GIS, he has to know even more..." (IICA notes, 18-09-97).

3 Strategic planning of the 'development axis'

"IICA proposes a GIS to overlay biophysical information with socio-economic information, to make recommendations on 'competitive land use'. We are only interested in working with groups of farmers, so the scale does not matter so much... we have to think about 10, 20 farmers and unities of 100 ha. or more... Information on existing industries should also be linked to agro-ecological zones..." (IICA notes 26-08-97). This approach was conservative in that it was biased towards existing regional industries, such as e.g., the orange production in the Northern Zone, because of the existing orange factory. IICA also started from the investors' point of view, not from the farmers', by looking at efficient investments, rather then efficient interventions that improve farm production. IICA hoped that at least the Regions would define whether they are 'a fruit tree area' or a 'vegetables area'.

4 Micro-watershed planning

"By using a GIS to present a Digital Terrain Model and the hydrology, one will always end up by planning in watersheds. It is especially useful if there are problems with water or erosion". Also "..it has to be participatory because the state doesn't have any money, but the technician, as a facilitator, still should make sure that the natural resource component stays central. Micro watersheds are useful because 'people know each other, and after a while a natural leader will take up the issue and everybody will become a soldier for their own watershed.... if the area is too big, the interests are too divergent". (IICA notes 22-09-97)

5.4.2 Expertise and data aspects of GIS implementation (1995-1998)

While in the first period (1990-1995) limitations of training and data played a role in the slow development of the GIS of the GIS Department, in the second period (1995-1998) data access and data production became even more crucial. In this second period, at first no investments were made in the GIS Department. Initially, the proposal for the elaboration of soil maps by the Ministry of Agriculture was blocked by the new presidential Committee for Intersectoral Land Use Planning, TERRA. In 1997 the situation changed when the Ministry gave soil mapping responsibility to the GIS Department. The Department suddenly had a strategic asset to guarantee its survival.

The IICA project intended to use the technological advancements and data of the GIS-Department, but the Department only wanted to cooperate on its own terms. It is precisely here that we can analyse the relationship between the human agents and the technology as the basis of implementation potential and problems. In other words, the technological developments and problems of the IICA project can be understood by analysing the power of expertise and information. To understand what happened we first have to understand the developments within the GIS Department.

In first period the land evaluation model 'ALES' was seen as a threat. The spin-off of the ALES experience, however, led to a cooperation project with CATIE, which trained personnel from the Ministry and adapted the method to the Ministry's software. One of the Office's specialists continued experimenting with this application. He was supported by the Office, as long as he did not challenge the 'official land use capacity system'. More people in the department also started experimenting with the GIS and slowly learned to use its products. With the data of the FAO project and the data from the project for the Pacific Region, the personnel of the (former) Office for Land Use Planning quietly began to apply GIS without anyone taking notice of their isolated advances. In 1996, the information from the Pacific Region Soil Mapping project was linked to a crop-zoning database, while specific studies at the local level were digitised. Some personnel trained with new modules of their GIS-software, and surprisingly enough (given the earlier resistance), the GIS-Department even trained some Regional Offices in the application of ALES. With increasing confidence, the Department explained its apparent change in the use of GIS. The Department first defined interesting areas for intensification, according to its land use capability map. In these areas, more detailed studies would indicate interesting areas for specific new export crops, while afterwards, with the use of ALES, the feasibility of introducing these crops could be calculated and visualised. If the extension service or a regional office would use ALES, this would only further emphasise the relevance of their approach.

To be able to launch this strategy, the Department first faced the challenge of negotiating its way through the institutional shifts presented by the creation of the Intersectoral Committee

for Land Use Planning (TERRA). One of TERRA's tasks was to function as intersectoral information provider. Information of the GIS Department of the Ministry of Agriculture became very strategic and the Department itself was not sharing it with anyone. Data were used as a means to keep power, as we have discussed at length in Chapter 4. Referring to the presidential committee the Department warned against handing out information 'just like that':

> *" [the committee TERRA] is just a group of consultants who are close friends of the president, .. they asked us for information, but together with the [NGO] Fundación Neotropico we decided to not send any ... when they visited us we gave them just some information, but of course not everything.... ...TERRA is more a political committee than something for the national interest...after the elections TERRA will just disappear and with it the information... If you want to work together with other groups you also have to trust the other...and you have to be sure that the information you give will not be abused. We know of cases that information we handed over was later sold to others for thousands of dollars. That is corrupt and the government pays twice..."*[32].

After the approval of the soil mapping in 1997, the Minister demanded a presentation of all GIS products from the Department. The products were displayed for a week in the entrance hall of the Ministry to show the potential use of such information products. We could suggest that the decision to display the GIS products resulted from the need to educate people in the sector who did not know exactly what data were present, and what it could be used for. More importantly, however, the awe-inspiring colour images helped to underline the perception that any such technology was rightfully considered prestigious and was a powerful factor for sectoral planning. This was a display of symbolic capital.

At this point can we return to the IICA and the project that it executed in cooperation with the Department. When the IICA project team decided to include a GIS in its 'computer network plans' it did not understand the information feuds very well. The team consisted of a manager and mid-level officials from the Ministry, who never had had any experience with GIS. To prevent a total dependency on the GIS Department, the IICA team asked the public universities and the GIS Departments in other sectoral institutes to cooperate. Warned about the difficulties, time and money it would take to implement a GIS, they gradually limited their goal from an actually running GIS to 'formulating an implementation plan for GIS' in the Regions. Also, without any project money secured, they could not begin with their plans until after having convinced the sector to approve a project. Therefore, they decided to make some attractive examples of GIS-use to present to the sector directors. The intention was to convince everybody of the necessity to

[32] Interview with high level ministerial official (M3, 4-06-97), meeting notes IICA project (12-08-97), and conversations with different ministerial professionals around a presentation of the GIS of the former Office for Land Use Planning to the IICA project team (IICA, 5-08-97).

finance the regional applications of GIS. At the public displays of the GIS-Department, the IICA team indicated they that wanted to use the experience of the GIS Department to make practical examples of regional planning from the available information.

Most importantly, IICA proposed that GIS was to be used for the formulation of the 'Development Axis' of every region, combining market information with land-use potential, and thus "opening the window to the world". But GIS was also to be used to geo-reference and visualise projects, credits, entrepreneurial activities and farmers' organisations. Finally, GIS would help to link technology transfer with agro-ecological zones and stimulate local planning through the concept of watersheds (IICA, 1997b,c). The GIS tools employed by Regional Teams of Experts would assist in formulating interesting projects starting from the comparative advantages of the Region. One key aspect in all GIS applications was that information would be available at the regional level.

Considering these IICA proposals for GIS use we can suggest that, at least on paper, the ideas seemed to come close to the ideas of the GIS Department. To understand the difficulties of GIS implementation of the IICA project and its influence on the Department's GIS we have to take the negotiations on the work floor into consideration. Only then can we fully understand GIS implementation as an interactive process involving technology and human agents, institutions and politics.

5.4.3 Actual implementation of GIS (1995-1998)

This section will describe how IICA tried to promote a Regional GIS and involve the GIS Department. To reduce the dependency on the GIS Department, IICA consulted different GIS specialists of other sectoral institutes and universities. For IICA it was not automatically necessary that the GIS Department of the Ministry would be coordinating or developing plans and models for regional planning. If the Department had a role to play, it was one of maintaining information and training staff for Regional Service Centres. When it tried to involve the GIS Department the IICA found closed doors.

Defending its data monopoly, the GIS Department stated its concerns. It did not agree with handing out information. It referred to its superiority and expertise, arguing that the regional office 'could by mistake change maps, official information, or create erroneous interpretations'. The GIS Department only wanted to train the regional offices in simple applications of standard procedures. To give the raw and basic GIS-data to the regions would be useless and even dangerous, according to the Department.

> *A GIS-Department representative: "What we did was to give people training in ALES, how to make a decision model.... we also indicated to them where they could find the information necessary to run ALES.... We have a natural resources database and a socio-economic database, although the information is outdated. We didn't teach them to*

manipulate data, because you know how that goes...before you know it we have 20 versions of what is happening in a region...We always gave information and training, but what happens is that after the meeting they forget everything... and than we get the feeling that we are wasting our time... "[33].

By showing the formal willingness to cooperate, the Department tried to create goodwill within the Ministry. When the IICA project tried to get cooperation in June 1997, the official approval for the soil mapping project was not given. Once the soil mapping project was approved in August the Department's attitude changed to a more challenging strategy. The GIS department defined itself as central to GIS development and as experts that could not be replaced. As the GIS-Department was the only specialised group in the Ministry they would have to be asked to do 'real research', while some mapping exercises or applications of their plans and studies could be done on regional level. In fact, they presented the IICA project as a way of applying and using the studies they had been working on all along. IICA only had to come up with a way of organising the use of their expertise. Instead of directly cooperating, the Department challenged the IICA approach. It demanded that the IICA change plans and make the Department a central player in its project.

"I always get offended when people from this building come to my office to ask for a beautiful map for a report here or there... That is why I am happy with your proposal, because this is a very intelligent way of using GIS. It is the first time that someone brings up something this intelligent... Finally we can use it for what it was meant for... People get very impressed with what we show them on the screen, but the big problem is that very often the information is not used at all." " We have experience with these kind of projects, and it is always very important that you know exactly what you intend to do...GIS is a tool, but what is your objective?" "What you are doing is very broad...we are working more specific, we do research and make land evaluations".[34]

If we examine the actual GIS implementation by IICA, we can see how the notion the strategic use of information in times of institutional reform was not taken into consideration. Frustrated with the lack of cooperation, the IICA project tried to force the Ministry's GIS-Department to cooperate, enforcing the ministerial hierarchy. "[they] are really sitting on their information... I had people telling me that [they] only listened to orders from above...so we finally convinced them to cooperate.. [laughing].. by means of a letter from the Minister.."[35]. The pressure from the Minister only led to more resistance. The department obstructed the IICA project by strictly doing what was asked of them, in a very formal manner. When asked for an example of crop zoning of one Region, instead of giving its

[33] Meeting notes IICA 12-08-97.

[34] High-level representative of the GIS department. From IICA meeting notes 05-08-97 and 12-08-97.

[35] IICA team member (IICA, 8-8-97).

digital databases, which could have been used for crop zoning, the Department only gave old information in paper format (the 1988 crop zoning of 1:200,000). When asked to help with GIS database building, the Department answered that its formal task and priority at that moment was somewhere else, because "...we are too busy with preparing for the new maps 1:50,000. We can help you in the evenings hours, but you will have to pay us as consultancy, because it is work in over-time"[36]. The IICA project finally digitised the crop-zoning maps by themselves. This example illustrates how data and expertise were used as a strategic asset to boycott full cooperation with IICA's GIS project. The outcome of the power struggle can best be illustrated with a description of the various versions of the proposals for GIS implementation, as elaborated by IICA and the Sectoral Secretariat. The proposals can be considered an indication of the negotiations, and illustrates how the actual implementation was a reflexive process.

The various versions of the proposals for GIS implementation showed a shift of the locus of control of the actual GIS. In a first draft version of *'the implementation strategy for GIS'* (IICA, 1997b), made for the IICA-project by the Sectoral Secretariat of the Minister, GIS was to help with a 'permanent actualisation' of information and it would permit to get a complete picture of the resources of all sectoral institutes. The document stated that Sectoral Secretariat was to be responsible for the "operation" of the GIS, together with a group of technicians of other sector institutes. The Sectoral Secretariat would coordinate this group, showing the strategic use of the GIS project to transfer control over the sectoral institutes to the Minister (and the Secretariat). The document also called for quick action to use existing GIS applications [meaning the GIS Department], "..that are unknown, or not well integrated..." (IICA, 1997b).[37] In this first proposal, the IICA-GIS was mainly intended to be used as visualisation tool for administrative planning of the Sectoral Secretariat, in support of strong central guidance by the Minister. The next version of the document on GIS implementation had changed in intention, because "the GIS-department doesn't want the Sectoral Secretariat to get a GIS... We will therefore implement the GIS project at the IICA office"[38]. The Sectoral Secretariat would be written out of the work plan for the GIS implementation. The third draft, made after a meeting with the GIS-department, finally indicated that the importance of the whole project was not "the operation" of GIS, but the **design** of GIS for regional applications. The report explicitly omitted that GIS would serve the Sectoral Secretariat to get information from the regional institutions. Instead the report emphasised that a regional GIS was to 'serve all sector institutes and farmers' (IICA, 1997c&d). So in the compromise version of the IICA-GIS, it became more of a regional tool

[36]Meeting notes IICA 18-08-1997.

[37]Meeting notes IICA, 17-09-1997.

[38]Meeting notes IICA, 17-09-1997.

for 'different applications' that had to be defined subsequently with participation of the Ministry's GIS Department. According to the proposal, information (in contrast to the opinion of the GIS Department) would become freely available.

> *When, finally, IICA presented its last version of the GIS proposal to the Board of Directors of the sector institutes, it made a final attempt to convince the GIS Department to cooperate. The strategic data issue was still the most important limiting factor for the project, and IICA suggested that without a GIS the whole INFOAGRO information network was impossible. IICA had the Minister urge the GIS department to open up its information systems: "The discovery of what we have is very important, the press always want to convince us that we cannot do anything, but we have everything here. [to the GIS department director] ...Luís, as you say the soil information is there but farmers don't use it. But everybody can have access, and we should make it accessible for small and medium farmers. We have to give them fever, enthusiasm. Also the private sector has to have access. Is that a problem? If they can use it is all the better!"*[39]*. The problem was however that also basic information would have to be decentralised, which, as we already mentioned was boycotted by the GIS Department of the Ministry. For them information was not a free resource but a means to survive.*

The vision of open liberalised information and market mechanisms facilitated by GIS, clashed with the regulationists of the GIS Department, who saw institutionalised information as a key power source in consolidating its position and stimulating centralised planning of the sector. By compromising with the 'populists' on the earlier mentioned *Land Use, Conservation and Management Law,* in 1998, the GIS Department gave a final blow to the IICA initiative. With the law in hand its survival was officially guaranteed. The law defined tasks for both the (former) Erosion Service and the GIS-Department for Soil and Land Evaluation, which became responsible for 'official' soil information for the land-use capacity system. The Office would now become responsible for coordinating the activities of Regional Offices and other sectoral institutes from its central location, in exchange for concessions to the populists, on participation of farmers in local planning processes. By 1998, the GIS department did use the field method ALES for analysis of specific problems at the local level, and it became responsible for explorative studies on fruits in the Northern Zone and Pacific Region towards planning new projects using investments from abroad (MAG, 1999). With the lack of resources and resistance by the most important actor, it was no surprise that the 'GIS' part of the IICA project failed. The internet connections and the creation of a website 'INFOAGRO', however, were successful.

5.5 Conclusions

This chapter has described the implementation of GIS in the Ministry of Agriculture, during the period of 1990-1998. It has done so by looking at 3 major GIS initiatives, and its key players, each with their own planning vision. Implementation was slow and riddled with

[39] Minister of Agriculture Garrón 18-09-97

problems. Moreover, throughout the years, the government changed the goals of GIS implementation several times. Mainstream GIS literature with a technological focus would have tended only to consider the technological and management problems of GIS implementation. It would not have been able to explain GIS-implementation as a negotiated process between contending power groups within the Ministry of Agriculture.

Implementation was discussed as a reflexive process of human agents within their context (Figure 5.1). This involved considering the presence of data (arrow c), financial resources (arrow f) and political support (for example, for institutional change of the GIS location), as well as the 'institutional niche' of the agents of the GIS location (relation between these agents and field of land use planning). The approach helped to understand that funding of GIS projects and choices during GIS implementation were dependent on the policies for institutional change. Three contending groups competed for influence on GIS implementation: the market proponents, the regulationists and populists. The GIS projects in the Ministry reflected the planning intentions of two governments in the nineties. The Calderon government stimulated a regulationist GIS. The Figueres government worked towards an intersectoral and, later, towards a market oriented GIS. It was necessary to incorporate the institutional dynamics and reorganisations to understand how government intentions of stimulating a specific version of planning and GIS were diverted by a strong state bureaucracy. Delays in the first period (1990-1995) were caused by both internal disagreements over planning and different ways of working of the Erosion Service and the Office for Planning. In the second period (1995-1998), a government project (referred to as the IICA project) failed to transform and use the Ministerial GIS for regional applications and to make the GIS information openly accessible. Its principle goal was that information would be used to help farmers and investors to find new agro-ecological areas or interesting crops. While the failure could be partly attributed to a lack of resources and expertise, the most important limiting factor of the market oriented GIS project was a fight over bureaucratic control and sectoral interests. In defence of the sector against transfer of territorial responsibility to the environmental sector, the regulationist use of GIS was accepted in a compromise between the populists and regulationists.

Using the techno-structuration approach, we now understand that GIS can be used strategically to keep responsibility over land-use regulation, attention to farmer research and extension in marginal areas all within the Ministry of Agriculture. The chapter has illustrated that a central database and simple applications of GIS were, therefore, more important than prestigious scientific applications or the practical usefulness of GIS for land users and policy decisions. So even though GIS was not (yet) directly used as a planning instrument, it was used to maintain power in the sector (legitimising/talking about planning and GIS). Finally, with its central nation-wide database, the GIS Department of the Ministry had many future options (and plans) for selling information services for applications that were intended to be freely available in the market project.

6

GIS Implementation for Forest Monitoring

Introduction

During the Earth Summit in Rio de Janeiro nature conservation and forest protection were put high on the international agenda (Kolk, 1996). Third world forests had to be protected and deforestation halted as part of measures against global warming. GIS and remote sensing were presented as important tools to help monitor biodiversity and deforestation and plan forest use. This chapter will again use the techno-structuration approach (Figure 6.1) to understand how GIS for forestry regulation was implemented in Costa Rica.

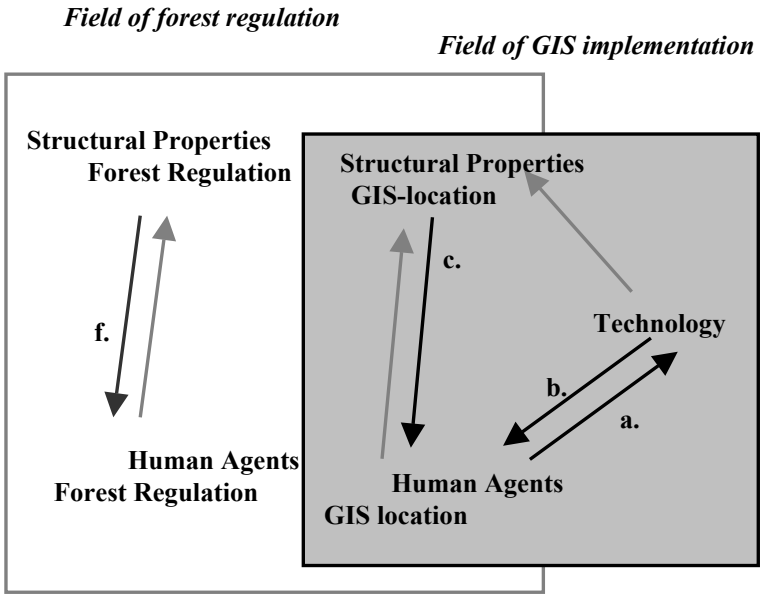

Figure 6.1 Techno-structuration of a national GIS in the forest sector

a.& b. GIS implementation as a negotiated process by human agents
c. The influence of data and expertise on GIS implementation process
f. The influence of planning and policy priorities on the promotion of projects of GIS implementation
(arrows in grey will be dealt with in the last chapter)

Our overview of GIS in Costa Rica throughout the 1990s, Chapter 4, showed that many GIS locations were linked to environmental sector. In the early nineties for example, NGOs took over management tasks regarding state forest land, and developed GIS for forest monitoring and conservation. This chapter will illustrate how changes in the institutional landscape of forest regulation during the nineties, led to shifts in the location of GIS (state) forest

monitoring implemention. These shifts in GIS location went together with a different perception of regulating forest land use, and influenced the 'models' built into the GIS. Mainstream approaches to GIS implementation would, at worst, not take the relations between different GIS locations into consideration at all. At best, they might describe organisational links, but would take differences in motivations and models at face value. The advantage of our approach is to be able to understand how a specific choice of 'models of forest regulation' led to support for a specific location (with its own vision of forest regulation). These visions had consequences for the implementation process and influenced the applications of GIS.

To understand this complex process of GIS-implementation, this chapter first gives an overview of the main issues at stake in Costa Rican forest regulation (Section 6.1). To understand the institutional embedding of people involved in GIS implementation we will describe their relation to wider discussions on forest monitoring, as part of networks of certain pressure groups (or, the field of forest regulation, see Figure 6.1). In the second section (6.2), I will give a short introduction to the (shifting) location(s) of GIS implementation for forestry regulation throughout three periods during the nineties. This explains the reasons for the periodisation of this case study (as described in the following).

Section 6.3 describes the main GIS developments from 1990 to1994, a period of sectoral specialisation and support for environmentalist NGOs involved in management of Costa Rican forest areas. GIS was developed within these NGOs. The second period, 1994-1996, is a transition period, in which government support for environmentalist NGOs declined. Even though GIS development based on State initiatives came to a standstill in this period, one NGO with a market philosophy towards forest regulation, developed new forms of forest management and GIS models. This GIS will be described in Section 6.4. In the third period, 1996-1998, the government embraced the market approach to forest regulation and copied the GIS methods developed by the aforementioned NGO (Section 6.5).

In approaching each of these short periods, I organise the text following the implications of the techno-structuration approach. The first part describes the influence of government choices to finance certain GIS projects and promote institutional reform, enabling or limiting certain groups to promote their vision of forest management (arrow f) and the relation between structural properties of forest regulation on the properties of the GIS location. The second part analyses the influence of the specific institutional properties of information production (and GIS) in the forest sector on the human agents (arrow c). This involves especially understanding the presence of expertise and data, as requirements for (certain forms of) GIS implementation. The third and last section, looks at the actual implementation of GIS, illustrating the importance of the institutional context, and the content of the discussions above (arrows c and f), for the choices made during implementation (arrows a.

and b.). We summarise the main findings in Section 6.6. The complex shifts in the location of GIS for forest monitoring, and the models that built as a consequence of the institutional and political backgrounds of the people involved in GIS implementation could only be understood by including the context of the content of GIS in the discussion. The final choice of the government for GIS development for monitoring of market mechanisms of forest land use had deep implications for the character of information and insights into land-use change in the field.

6.1 Discussions on Forest Regulation in Costa Rica

This section describes Costa Rican forest regulations during the nineties. It includes a discussion of different groups in the sector promoting certain changes in policies and forms of implementation for forest regulation. These forestry sector groups all had different perceptions of how information and GIS could contribute to better forest regulations. Different strategies for forest regulation implied different expectations of GIS and different 'models of planning', which were to be implemented in the information systems. By describing the link between these groups and the locations of GIS implementation in the forestry sector, the section provides the background to relations between GIS builders and the 'field of forest regulation'.

In the late seventies, GIS was already used for the forestry inventory in Costa Rica. A study pointed to high deforestation rates, and the need for 'informed policies' to protect remaining forests and to stimulate sustainable forestry (RDA, 1979). Information was (and is) widely seen as strategic for monitoring, planning and controlling the forest areas (OFIPLAN, 1977; Maldonado, 1998). The way in which sustainable forest management should be achieved, however, was under constant discussion (Watson et al., 1998:46; Carriere, 1991; Silva, 1997). The Rio Conference, in 1992, generated new reasons for forest protection: the prevention of loss of biodiversity and global warming. The dynamic Costa Rican environmental movement quickly picked up these issues. In the early nineties, the government stimulated NGO involvement in managing its forest resources for biodiversity protection, while after 1994 the government subsidised sustainable forest use through 'environmental service payments', as reward for forest use that prevented green house gas emissions.[1] The implementation of these new ideas took place with reduced state budgets and under constant institutional change. The structural adjustment policies of the nineties implied a reduced state budget and pressure to deregulate. As described in the history chapter, direct state regulation was also contested by a strong environmental movement. As a result, government policies were favouring new experiments with

[1] Costa Rica was a pioneer and promoter of this new idea. It signed the first agreements of intent for 'Joint Implementation' with the USA and worked hard 'to be first'. The result was that Costa Rica was engaged in 8 out of the 15 world-wide projects that the United Nations Office for Joint Implementation approved in the first years (Michaelowa & Greiner, 1998).

participatory and market based strategies towards forest use regulation. Most importantly, the forest legislation was under discussion, which gave rise to different proposals for adaptations in the existing regulations of the early nineties.

To understand the changes and issues at stake, we have to look first at the regulations. In 1998, at least 25% of the total Costa Rican territory fell under some form of regulative regime as 'Protected Areas', and the country was often lauded internationally as 'the champion of nature conservation' (Wallace, 1992). In Costa Rica there were two major categories of 'Protected Areas': National Parks and the 'Other State Reserve Lands'. While both entail a degree of protection, in National Parks, all forms of intervention were prohibited, while in the other Protected Areas, there was a degree of flexibility in terms of activities. As we will describe later, this flexibility created room for private interests to exploit forest resources. Besides the forest areas in these Protected Areas, 'unprotected forests' were officially regulated by the 'Forest Department', trough a 'land use capacity' system and later by the Forest Law of 1996.

Throughout Costa Rican history, the concept 'Protected Areas' has been dynamic (Rodriguez, 1993). While in the 1970s state intervention was seen as the only way to protect the remaining forest areas, in the eighties, new ideas of co-management and private forestry were put forward as alternatives to the strictly regulative role of the state. This trend partly reflected the change in categories of 'Protected Areas' that the state declared[2]. In the early seventies most National Parks were put under state ownership and strict protection. In the late seventies Forest Reserves were established, permitting (regulated) private forest management. In the eighties most Wild Life Reserves and Protected Watersheds were established, in which private (regulated) ownership was permitted (Rodriguez, 1993). Forest Reserves, Wild Life Reserves and a few other categories are therefore referred to as 'permissive Protected Areas'.

Officially, all intervention was forbidden in the National Parks. In the 'permissive' Protected Areas, forest management was permitted, but only under state control. The state tried to limit the claims on land in Protected Areas to a minimum, making it difficult or impossible to legalise titles[3] after the official declaration of a Protected Area. The reason behind this was that private landowners, whose territory fell under National Parks, were protected by the Constitution from intervention from the state. Their right to private property was sovereign and for this reason, these owners had to be bought out by the state, before the regulation

[2] Around 85% of the Protected Areas were established by presidential decree. This often meant that long term financial backing by the National Assembly and the state system was unavailable, and the officially required studies on ecology and land ownership were not undertaken. Of these areas, only around 15% were confirmed years later by law (Rodriguez, 1993:83; Garcia, 1996a: annex 2).

[3] Often farmers occupying lands in these areas did not have legal titles, because of the difficulties and costs involved in the paperwork for an official status, which had to be arranged in the capital city, far away.

regime could be enforced. In the 'permissive' Protected Areas, the state had difficulties in enforcing limitations on land use[4]. The state was therefore also forced to buy out landowners in these areas, or convince them to voluntarily comply with the regulations through subsidies or other benefits. Considering the large surface area of these protected areas (still in the hands of private landowners), and the small amount of money available for land purchase, the state was forced to look at different enforcement strategies.

Table 6.1 Protected Areas in Costa Rica and % of Private property within its boundaries
source:www.sinac.go.cr (2002) & Garcia (1996a)

		Total Area (ha.)	% of National Territory	% Private Property
Strict Protection		589,000	11.5	17
Permissive Protected Areas	Forest Reserves	283,000	5.5	
	Wildlife	175,000	3	71
	Reserves Others	251,000	5	
Total		1,298,000	25	46

The table shows that most areas under strict protection regimes (National Parks) were in state hands. These Parks, created in the seventies, were often State Reserve Lands, unsettled and unclaimed. Otherwise, most Parks were expropriated following the stipulations of the law. In the eighties, the more 'permissive Protected Areas' were created. These areas were declared during economic crisis and the state could not buy out the many landowners.[5] Interpretation of the high percentage (71%) of 'private lands' in permissive Protected Areas (Table 6.1) must be somewhat nuanced, however, as large parts of these areas were in the hands of state institutes (such as the Institute for Rural Development) or owned by Environmental NGOs that had bought land with foreign donations or through 'debt for nature swaps'.[6]

Declaring an area as 'officially protected' did not automatically mean that land use in the area would change. Data to prove that forest land-use change took place, however, was contested (Box 6.1). What became clear in many studies was that most of the remaining primary forests were to be found in 'Protected Areas'. Total actual forest cover varied widely, because of technical problems and choices made in interpretation (Pedroni & Velasquez, 1998).

[4] In practice, the Forestry Department was understaffed and underfinanced. It therefore could not enforce the law in all forest areas (Campos, et al, 2002). Moreover, after private owners had won a court case against the limitation of their rights in the permissive Protected Areas, there was not a lot Foresters could do to enforce protection (AI, 12-04-2000).

[5] People actually living on the land and/or with a legal tittle had rights to indemnisation in case of expropriation.

[6] Originally also NGOs were expected to transfer their lands (often bought with donor funds through the debt for nature swaps) to the state, but especially in the forest reserves and wild life reserves, NGOs were neither obliged, nor willing to transfer the title.

Variation was high because of the limitations of satellite technology and different definitions of 'primary forests', 'intervened primary forests', 'secondary forests' and regeneration areas containing shrubs and trees.[7]

Not only was there disagreement and wide discussion over the exact cover area of Costa Rican forests, but also how to improve forest regulation. Diverging data were often used to demonstrate certain positions in the forest regulation debate. Some people reported that state policies were successful in reversing the high rates of deforestation in the seventies and eighties (Gonzalez, cited in MIRENEM et al., 1995a), while others reported alarming deforestation, fragmentation and deterioration of remaining primary forests (Sanchez, 1996).

The arguments in this discussion on forest regulation were made by three groups, similar to those we met before: the environmentalists, the market proponents and the regulationists. These groups were promoting different strategies of forest protection and management, to be discussed below. With diverging strategies, the groups also disagreed on the location of GIS and the 'models' and data it should produce (Table 6.2). The situation resembles that described in Chapter 5.

Table 6.2 Forestry visions and its consequences for GIS projects

GIS projects	**Regulationists** GIS Office for Conservation Areas	**Environmentalists** PACTO/CIEDES	**Market Proponents** FUNDECOR/ FONAFIFO
Intervention areas	National/Regional Division	Decentralised Parks & Buffer	Buffer zones
Governance	Top-down	Participatory	'Dialogue' with private sector
Inter/sectoral	Intersectoral	Intersectoral	Sectoral
Natural Resources	Public	Public/private	Private
Intervention	Global Master Plans In field control Taxes	National Protection Subsidy 'No Use' No cover change	Global Environmental Services Markets
GIS-use	Inventory/Planning Enforcement	Local Monitoring Enforcement Biodiveristy & Land Use Capability	Guaranteeing transparency markets Field Management

[7] Also clouds and image availability have limited remote sensing applications making the technology useful only when no alternatives are available. Normally, other material like aerial photography and local inventories have given better results, and only these other methods have made it possible to detect selective logging, species differentiation and more detailed land cover classification. In a critical review, Holmgren & Thuresson (1998) concluded that Remote Sensing is only useful for nation wide global scale inventories, and for detecting clear-cuts.

Box 6.1 Data discussion on Forest Inventories

Although there has been wide disagreement about the total forest area, most inventories indicate a growing loss and fragmentation of primary forests, and depletion in biodiversity. The amounts in Table 6.2 show the confusion over forest inventories. Leclerc and Hall (2000), in a summary study of Remote Sensing in Costa Rica, judge the forest areas in the IMN-study as 'substantially overestimated'. Still, the prestigious National Fund for Forest Finance (FONAFIFO) study, comes closer to the IMN study than any other inventory. Sanchez later recognized that because of the timing of the satellite images his study did not include the deciduous forests in the dry Guanecaste area (around 330,000 ha). Also the' non classified' area around 9% (460,000 ha.) of the national territory almost certainly contains forest areas being part of the Parks or areas classified as forests in other studies. Fallas, in a research on the Northern zone, also criticises the IMN-study. The IMN study showed that of the primary forest land use established in 1984, by 1992, only around 270,000 ha. Remained. The total forest area in 1992, however, was estimated at 336,000 ha. Fallas classified this difference of 66.000 ha. in his own study mostly as pasture areas (54,000 ha) (Proyecto Estado de la Nación, 1998: 297). Still, Fallas estimated reforestation at 205,000 ha, suggesting a net reforestation in the area for 1992, or at least a net stabilization of forest area (Proyecto Estado de la Nación, 1998:271). All authors agreed that still primary forests have been reduced causing a qualitative change, fragmentation and loss of biodiversity in Costa Rican forests. Official estimates in the nineties indicated that there were around 215.000 hectares of primary forests with 'production potential' under some from of protected status (e.g. in Forest Reserves or Protected Watersheds) and 218,000 hectares of primary forests on private lands (MIRENEM et al., 1995a). Many Protected Areas within the more permissible protection regimes contained also 'secondary' forest classes (Sanchez, 1996; Leclerc & Rodriguez, 1993). Many authors have noticed a growing amount of secondary forests and the slow regeneration areas of abandoned cattle areas (e.g. Berti Lungo, 1999; Kleinn & Pelz, 1994; Watson,et al.,1998). Also, over the years, the state subsidised around 140,000 ha. for the establishments of forest plantations (SINAC, 2002).

Table 6.3 Forest Cover

Forest cover study	Year	Total Area Studied	Forests (ha.)	Description
MIRENEM, in Wendland & Bawa (1996)	1987	100%	750,000	Primary
FAO in Leclerc & Hall (2000)	1990	100%	1,430,000	Primary
Sanchez (1997)	1991	82%	1,360,000	Primary
IMN (1996)	1992	100%	2,460,000 1,290,000	All Forests Primary
Fallas & Sawitsky (1997)	1992	100%	1,700,000	Primary
FONAFIFO (1998)	1996	91%	2,017,000	Dense Forests
Watson et al. (1998)	1997	100%	2,400,000	All Forests

Contrary to what many consultants and scientists in the Costa Rican GIS/remote sensing community indicated (e.g. Laake, 1999), these scientific studies with satellite remote sensing showed such a wide range of interpretations that they did not contribute to more clarity[1] on the subject of forest inventory and management. Different methods, together with clearer definitions on forest types are required to make more precise estimations (Holmgren & Thuresson, 1998; van der Sanden, 1997).

The first group promoted a regulationist approach, the direct steering of forest land use. This group was dominant in the forestry sector state bureaucracy. It favoured state involvement and strict regulation of forest management. These 'regulationists' wanted to combine regulation and enforcement with a subsidy system for forest management. According to the regulationists, state subsidies for plantations would decrease the pressure on the remaining forest areas. State involvement in control of forestry practise in forest areas was seen as appropriate, or even an obligation to protect forests in the name of the environment and the common good. In strictly protected areas no intervention was permitted. In the other (permissive) protected areas, the aforementioned capacity system indicated where forestry could permitted, or where priority should be given for subsidy schemes (e.g., SINAC, 2000). Outside the 'protected areas', the regulationists claimed regulative responsibility over all areas with 'forest capability'. In forestry management the 'land use capability system' set limitations on forest exploitation in areas with (for example) steep slopes. While the capacity system was never really applied, after the approval of a new Forestry Law in 1996 (that stipulated that forest use could never be changed into other land-uses), the regulationists gained some influence over areas outside the protected areas. In the eyes of a regulationist state bureaucracy, GIS was necessary to make state intervention more efficient. GIS could be used on a central level to monitor overall land-use change and develop the National Plans for forest protection, production and subsidy assessments. Regional Offices of the Environmental Ministry would use the GIS for administration and control of management plans and subsidies. GIS would also help the Regional Office with planning field activities for control of forest management and protection, by assigning priority areas for patrolling (Munting et al., 1996; USAID, 1994; COSEFROMA, 1996). GIS was introduced first in the Central Forestry Office in 1992, but only became functional after 1995. As we will explain later, its development was influenced negatively by the development of GIS in other locations of the forestry sector.

The second group we can identify can be categorised as "environmentalist". This group consisted of an alliance between those wanting strict protection, and those advocating a more participatory approach (which included co-management of parks and agro-forestry initiatives). This environmentalist group consisted of many NGOs, academics and part of the state bureaucracy. They were generously supported by international donors. In general, the environmentalists mistrusted the state bureaucracy. Nature had to be protected from the state and the private interests, be it loggers or farmers (Camacho, 1993). The state promoted - what they thought was – a 'productivist forestry sector'. Moreover, this group argued that it would be a lot cheaper to invest in a functioning enforcement system with foresters in the field, than to rely on a subsidy system to prevent deforestation (Wendland & Bawa, 1996).[8] Their

[8] Wendland & Bawa (1996:141) quote a World Bank study of 1991 that calculated the enforcement option to be less than 1 dollar/ha, while the subsidies and tax cuts amounted to hundreds of dollars/ha or more.

solution was the proposal of a 'no land use change' law for forest areas, while intervention and enforcement had to be focused on a regional and local level.

This environmentalist group, however, was divided in two. The more 'preservationist' wing was for a strict protection and a 'perish strategy'[9] for the people living in or around protected areas, while the more populist wing wanted subsidies for small farmers for low impact tourism, forest management and organisational support. In the eyes of the populists, participation of local people would guarantee responsible co-management. Both groups agreed that the state should be 'assisted' by environmentalist NGOs. The capacity system was seen as useful to regulate land use inside the protected areas with a permissible regime, but could also be used to stimulate the 'correct land use' in unprotected lands (Maldonado, 1998; Watson, et al., 1998). GIS use was seen as especially useful for controlling the state and private loggers. GIS could also be used for local monitoring of biodiversity, and controlling (limited) forest management and illegal logging. GIS could be used on regional level and assist in intersectoral planning for sustainable development. Finally, GIS would assist land titling and delimitation efforts in the protected areas[10]. GIS was stimulated in many projects of the early nineties in the offices of the NGOs assisting the state in the management of protected areas.

The third group were proponents of a market strategy for steering forest use. This group consisted of the private forestry sector (forest owners and industry), with a strong lobby from the USAID, which promoted strictly sub-sectoral planning. This group had considerable influence on government proposals. In their eyes, protection was reserved for the national parks and biological reserves, while market incentives should guarantee an economically viable and sustainable forestry sector in the rest of the country[11]. The group claimed that the forestry sector could manage a large part of the 'permissive Protected Areas'. In the words of a forest industrialist: ".. with our forest management and selective harvests, we are serving much better as buffers for the national parks than farmers or banana companies... we are therefore now seen as partners by the park system"[12]. This group wanted deregulation of the forestry sector. At the same time they experimented with the internalisation of environmental

[9] This strategy consisted of the abolishment of investments in areas to be protected, prohibition of giving credits and services for activities in these areas, and active patrolling to discourage people from settling there (Watson, et al., 1998; Moreira, 1998). This strategy was favoured by the Vice Minister Boza (1990-1994) and USAID officials, who proposed a law of expropriation of properties in National Parks without compensation (Rodriguez, 1993).

[10] GIS specialists in NGOs (N14, 24-04-97; N15, 5-12-97; N17, 5/8/97; N19, November 1998; N9, 23-09-96). But see also e.g. Maldonado (1998) and Laake & Rodriguez (1995).

[11] With this division they often could work well with the preservationists, as proven by vice-Minister of Natural Resources, Boza, who promoted this privatisation cum conservation road.

[12] Director of a large forestry operations company (P1, 25-10-1996).

benefits in the value of ‘sustainable’ forest products. They promoted a certification system to give Costa Rican forest products internationally accepted 'green seals' of approval. With cuts in state subsidies under the neo-liberal pressures of the nineties, the private sector lobbied for rewarding the forestry sector because it provided certain 'environmental services' (such as clean drinking water, protection of watersheds for hydro-electric production, and 'clean air', as part of the Kyoto agreements). For this group GIS was key for monitoring these 'environmental services'. The most important service was the service of prevention of carbon emissions, as was later negotiated at the United Nations Kyoto Conference on Green House Gas reduction. GIS was necessary for the scientific calculation of 'carbon fixation estimates', and for delivering a flexible and relatively cheap way of measuring forest cover (FUNDECOR, 1994:1995). GIS would also help improve management planning and harvest monitoring (Obando, 1998). These market proponents worked closely together with a particular NGO, the Foundation for the Development of the Central Cordillera (FUNDECOR), promoting a market approach to forestry issues. The GIS of this NGO played an important role in developing the market proponents’ proposals.

In this section, we have looked briefly at the issues at stake in forest regulation during the nineties. We have done this by reviewing the most important categories of forest regimes (parks, less protected areas and other forests) and different proposals of three groups for change or actual enforcement of these rules. The proposals were important in the light of a discussion towards formulating a new Forestry Law. Our description so far shows how different groups expect different applications of a GIS. Also, we saw that each group was actively stimulating GIS. This makes the case study interesting to see how the different institutional cultures and political intentions of different organisations actually influence models built in GIS. Now we have identified the main human agents and their ‘institutional planning niche’ (for GIS implementation) we can continue with the actual dynamics of the implementation process

6.2 Organisational embedding of GIS implementation

This section introduces the actual implementation of GIS in Costa Rica’s forestry sector. In this second case study I show how during the nineties, the location of GIS for forestry regulation and monitoring changed. This entailed GIS implementation in many locations. The governments in the nineties changed their vision on where to implement GIS supporting state forest regulation. By using a techno-structuration approach, I will be able to show how the choice for certain locations of GIS implementation was influenced by political and organisational decisions in the wider context. It also will be shown how the different organisational embeddings influenced the character of the ‘models’ built into the GIS. The GIS finally implemented in the state forestry system represented a specific shift in overall forest policy.

Our examination of GIS implementation (in these different locations) will be divided in three periods: 1990-1994, 1994-1996 and 1996-1998. Just as in the preceding case study chapter, I divided each time period in three subsections. First I explain the choices that governments made during the nineties to support or implement certain GIS projects for forestry regulation. This involves explaining the influence of the political and institutional shifts in forestry regulation on the institutional embedding of the location of GIS implementation (relation between institutional properties), as well as on the resources that enable (groups of) human agents (arrow f) to promote their vision of GIS implementation. Second, we will narrow the focus to consider the requirements for data and expertise of various government and NGO projects. The actual presence of data and expertise forms the 'technical resource' of the GIS location. We will focus on the structural properties of GIS. These consist of the 'technical prerequisites' for implementation and the institutional aspects of the GIS location. These last aspects can be derived from the influence that structural properties of the field of forest regulation have on institutional embedding of GIS. These properties enable and limit the actions of the human agents implementing GIS (arrow c). In a third subsection I describe the different expectations and choices that lurk behind the actual 'models' implemented. This section will again show that GIS implementation has to be understood as a process of political choice.

In the first period (1990-1994) the Calderon government promoted sectoral specialisation. Instead of integrating different offices involved in forestry issues into one Office for Conservation Areas (as proposed in the eighties), the Ministry of Natural Resources kept separate Offices for Parks, Wild Life Refuges and Forestry (Figure 6.2).

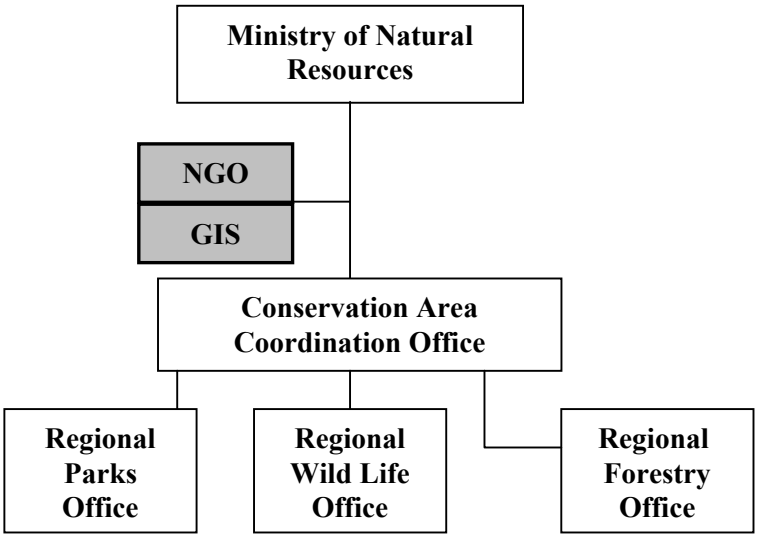

Figure 6.2 GIS location 1990-1994

It created a coordinating Office for Conservation Areas, with representatives from all protected areas. The Forestry Office was also represented in this Office for Conservation Areas, but also had separate responsibilities for non-protected forest areas. Within the Office for Conservation Areas, the National Park Service would be responsible for 'the core' of National Parks and the Forestry Office would be responsible for the buffer zones, regulating the remaining forests (of private forest owners in these areas), forest plantations and land designated as having 'forest capacity'. The government promoted strict protection in the National Parks and promoted 'private initiative' in buffer zones around parks. The country's Protected Areas were grouped in 'Conservation Areas', and for each area, an NGO was given a key role in the management of the protected areas and as coordinator between the different Offices of the Ministry (Wallace, 1992; Rogriguez, 1992; Watson, et al., 1998). During this period, the NGOs functioned as advisors to the Minister and most donor money was channelled through these NGOs. GIS implementation took place on 'Conservation Area-level', especially through NGO projects. GIS for forest monitoring was seen as the responsibility of decentralised NGO offices and their state counterparts.

The second period (1994-1996), will be described in section 6.4. The Figueres government totally changed the organisational structure and name of the Ministry of Environment and Energy (Figure 6.3). The Ministry of Natural Resources became Ministry of Environment and Energy. Most importantly, the Parks Office, the Wildlife Office and the Forests Office were reorganised into united regional Conservation Areas Offices. NGO involvement in official administrative matters was reduced drastically. The government however, was undecided over which policy to follow. At first it promoted central regulation, in 1996 it changed policies towards more market-oriented steering models for forest land use.

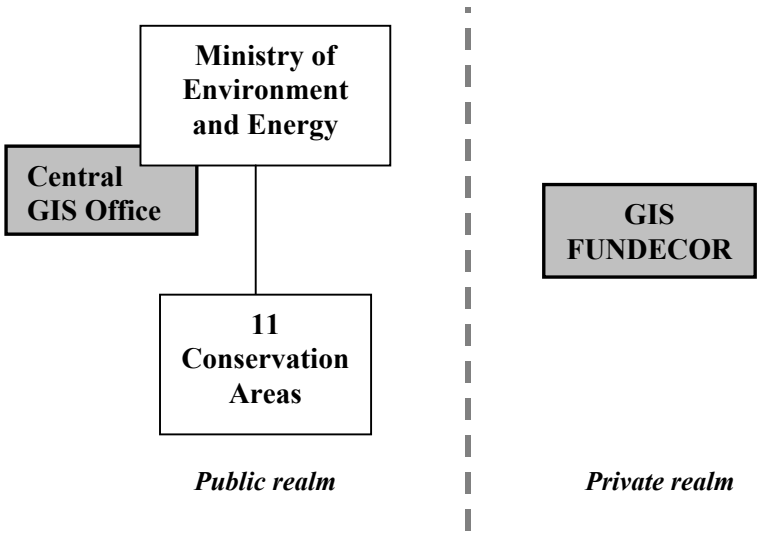

Figure 6.3 GIS location(s) 1994-1996

Even in this first period however, the market proponents were influential and promoting ideas of 'green business'. Part of the total reorganisation of the forestry sector was the formation of a central Ministerial GIS. Because of political indecision during this period, there was no support for investments in the bureaucracy, or for this central GIS Office.

While NGOs in general were losing influence, there was one exception. Far from the internal reorganisations and management problems, the *Foundation for the Development of the Central Volcanic Mountain Range* (FUNDECOR), developed new ideas for forestry regulation. FUNDECOR promoted a 'market'-strategy for stimulating sustainable forest land use, through subsidies of 'environmental service' payments, made for the service of 'carbon fixation'. Because this initiative was so important for the subsequent period, the GIS models of this market-NGO will be described extensively.

The approval of a new Forestry Law marks the beginning of the last period treated in this case study: 1996-1998. Section 6.5, describes how the Figueres government copied the 'models' from FUNDECOR and took measures to institutionalise the environmental services within the state system.

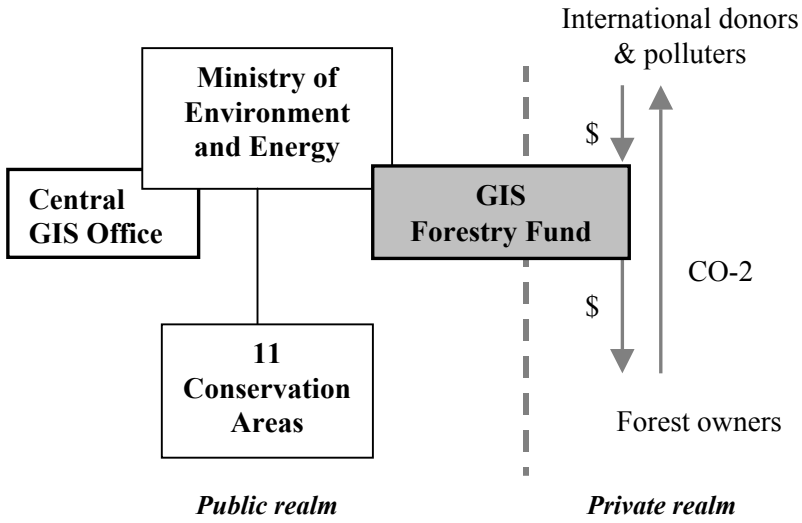

Figure 6.4 GIS location(s) 1996-1998

A complex system of environmental subsidies, organisations and monitoring methods was created (Figure 6.4). Monitoring the system (and the GIS implementation for forest monitoring) was the responsibility of the National Fund for Forestry Finance (an autonomous institute, under the responsibility of the Ministry of Environment and Energy). This Fund would pay environmental service 'subsidies' to landowners, and receive income for the prevention of carbon emissions from international players. This location was chosen for GIS

implementation because it was suitable for legitimising expenses to investors. GIS monitoring of carbon bonds was implemented through this construction. To understand the totality of GIS implementation, however, we must first return to 1990.

6.3 GIS for local projects 1990-1994

6.3.1 Government support for GIS: Projects and Policies

This section will describe the influence of the political shifts on institutional reforms and projects that supported GIS projects for forest regulation. In the period 1990-1994, the government supported a model of sectoral specialisation and NGO- involvement in the management of protected areas (GOCR, 1993). NGOs received large investments through the 'debt for nature swaps' (Chapter 3). In keeping with the neo-liberal climate, many donors channelled investments through NGOs, instead of investing in (what they considered to be inefficient) state bureaucracy. A national NGO for channelling donor money, the "National Parks Foundation", stimulated the use of this technology by environmental NGOs[13]. As a result, most GIS initiatives for parks and forestry were initiated by these NGOs. The state's National Park Service did not receive any funding for GIS, because state regulation under the Calderon government envisioned that forests and parks would be guided by the 'flexible management capacity' of these NGOs. Reflecting a managerial approach to park management (Redclift, 1986), the Calderon government claimed that NGOs would provide 'neutral and scientific' information for decisions making. NGOs saw GIS as useful for managing protected areas and forestry in a more neutral way, thus protecting the environment against both the state and the private sector. The GIS would help in administrating and monitoring forest permits, improve efficiency and control the state bureaucracy.

> *The most important GIS investments were made in Central Volcanic Mountain Range. Here FUNDECOR, which was the NGO created by USAID, implemented full GIS and Remote Sensing capabilities with assistance of the Tropical Agronomy Research and Education Centre (CATIE). In the Tortuguero Area, where the government had asked IUCN to help with the management, IUCN started a GIS. Also the Neotropical Foundation received funds to built GIS capabilities that were aimed to assist with the extension and land purchase in the Tortuguero Area, while they also were involved in the Osa Conservation Area. The Tropical Science Centre received its GIS as a donation for its responsibilities in the Monteverde Area, but they subsequently used it for extending its uses for scientific projects and consultancies on a national level. Finally Conservation International funded the GIS for the Amistad Area, testing software developed by the international office of Conservation International.*

[13] Two pioneers in GIS for environmental uses (NGO10, 23-02-1996; NGO9, 23-09-1996).

While most NGOs were linked to the National Parks Office, there was one exception, FUNDECOR. The *Foundation for Development of the Central Volcanic Mountain Range* (FUNDECOR), supported private forestry initiatives in 'permissive protected areas', in cooperation with the regional Forestry Office. FUNDECOR received generous support from USAID, which promoted the development of market approaches to forest management. FUNDECOR's GIS was also heavily supported by USAID, as a tool to improve administrative efficiency and for monitoring of forestry activities.

Box 6.2 Forest Management Assistance in the 'FUNDECOR'-project

The FUNDECOR project had as one of its goals the exploitation of the last remaining commercially interesting forests of Costa Rica (USAID, 1989a). FUNDECOR tried to improve forest management by helping landowners and loggers with the elaboration of sustainable management plans. They also assisted farmers with the necessary paperwork required by the state system, which they pre-financed. They slowly grew into a role of the (private) 'forest managers', responsible for the elaboration of the management plans. According to FUNDECOR, it would be often too costly for private forest managers or loggers, to involve small farmers into management and logging schemes. The cost of making a management plan would go down if many small landowners would participate under FUNDECOR rules (USAID, 1989a, USAID 1995). An evaluation of USAID mentions that the amount of area surpassed expectations. Still, mostly larger landowners were serviced, "to have a quick impact to protect the core area" (USAID, 1995). Forest management area under FUNDECOR's authority went up from 160 to 500 hectares in 1992, to 2970 in 1993 (Wendland & Bawa, 1996). The area grew from 8000 hectares in 1994 (USAID, 1995), to 12,000 hectares in 1995 under FUNDECOR contract (almost 17% of the total area of privately owned forest in the Central mountain Range Conservation Area). (FUNDECOR, 1995b)

Table 6.4 Area under contract with FUNDECOR for Forest Management and Reforestation in 1994 (own elaboration from: FUNDECOR/ACCVC, 1994)

Forest Management Area: 10865 ha; # 72	**<10 ha**	**<20 ha**	**>100ha**	**>750 ha**
% Area	**0.1%**	**4%**	**80%**	**55%**
% #	**4%**	**33%**	**25%**	**7%**

Reforestation Area: 1064; # 183	**< 1ha**	**< 3ha**	**>10ha**
% Area	**0.03%**	**17%**	**50%**
% #	**16%**	**52%**	**10%**

There was an overall lack of support for investing in the forestry sector bureaucracy, which was under a great deal of pressure to reform, deregulate and diminish in size. Within the Central Offices of the Ministry of Natural Resources, there was only one attempt to implement a GIS for a national forest inventory in 1992. The regional offices of the Ministry of Natural Resources did not receive any investments in GIS. Moreover, with the NGOs focused on the Parks Office and 'conservation', the regional Forest Offices were isolated and

often depicted by NGOs as corrupt. This led to frustrations: "...the accusations are widespread, but I don't agree. Even if sometimes we might help a farmer with a permit because we think it is just or necessary..., if you compare that 'crime' with the amounts of money the NGO officials take home, without producing any results? Now who is corrupt?"[14]. This quote illustrates the difficulties and tensions between the state bureaucracy and the NGOs, as a result of the reshuffle in responsibilities and transfer of management tasks to NGOs, during the Calderon period. As we will see later, this also had consequences for the actual implementation of GIS on the work floor.

6.3.2 Expertise and data aspects of GIS implementation (1990-1994)

As we saw in Chapter 4, during our overview of GIS in Costa Rica, the most important 'technical' resources enabling and limiting GIS development are expertise and data. Because the first central GIS project (1992) in the Ministry of Natural Resources failed due to lack of support and training[15], this section will focus on the NGO-GIS projects. Most GIS projects were actually run by one person, who often would have GIS tasks in addition to his or her regular activities. The GIS management itself was often not well thought through. NGOs only had money for specific projects and for given time frames, and therefore personnel were often hired on a short-term basis. GIS operators were no exception. On the one hand, the GIS operators had to discover by themselves how they could use a GIS to the full benefit of the NGO, and on the other hand they had to convince their colleagues of its usefulness. This was not an easy task. Not many NGOs had trained GIS experts. Another complication was that software, available in the early nineties, was user-unfriendly and difficult to learn.

GIS was expected to play an important role in 'scientifically' defining which areas should be included in the 'core' areas (National Parks), legitimising borders or extension of borders of protected areas[16]. This sometimes included inventory of land ownership in order to be able to buy out legal owners and expel squatters. Most GIS therefore started with the digitisation of land use capacity maps and maps of land use. With these maps, the NGOs indicated 'critical areas' or areas with a 'high ecological value' that were to become a priority for acquisition, protection and patrolling. During this initial period, most data was still only available in paper format, and GIS operators spent most of their time digitising. Most operators were 'learning by doing' causing even more delays, and the results were often disappointing and arrived slower than expected.

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[14] forest officials from the regional offices (M59, November 1997).

[15] officials from the Central Conservation Areas Office (M11, 2-09-1997).

[16] GIS was regularly used for discussing the borders of protected areas, especially when donor countries were willing to invest in land purchases for the protection of specific areas. Examples were the Tropical Science Centre, The Neotropical Foundation, the Project for the Tortuguero Conservation Area (Brooijmans, 1998). In other countries, GIS use was also stimulated by donors for this purpose (see e.g. Martin, 2000).

The GIS developments during this first period were still very precarious and unorganised. The most striking exception was the FUNDECOR GIS project. The FUNDECOR project had the advantage that all information already had been collected before the project started (USAID, 1989a). It also was set up with generous funding by USAID. With generous funds it could pay for a long period of GIS-consultancy support by the Tropical Agronomy Research and Education Centre (CATIE) (USAID, 1994).

6.3.3 The actual implementation of GIS (1990-1994)

The description of data and expertise problems has already given us an indication of the actual implementation process by human agents of the different GIS locations of NGOs. We saw how the process of learning how to work with GIS was often by trial and error and, GIS results were limited because of the unavailability of data. This section will further elaborate further on the actual implementation process to understand how human agents with the 'technical resources' and project money made specific choices for elaborating certain 'models' of GIS.

The NGOs had 'divided' up the country and the most important parks. This resulted in many different experiences with GIS. The GIS applications depended on the specific realities of the NGO and their regional responsibilities. For example, in one NGO (involved in land purchases within National Parks), GIS was used for the inventory of occupied land. In another NGO, the elaboration of a land use capability was seen as a priority, because of the elaboration of assistance programs for farmers in 'permissible areas'. The result was that every NGO developed its own specific database, with different data definitions and map layers.

Among NGOs there was competition for donor money. This, together with divergent work styles, led to infrequent communication between NGOs. As a result, data sharing was not common practice, and in cases when it was, projects discovered that the software or data formats, definitions and overlays were incompatible.

> *Illustrative of these problems is the case of the Tortuguero Area, where at first, maps from the Wageningen project were sold to the IUCN project in 1992. This data did not fit with the IUCN database of land use, because of a different base map. Also maps on land use elaborated by the Neotropical Foundation could not be fitted well to the maps of IUCN. When the Tortuguero Area received a second round of funding, IUCN stopped participating, but at first refused to hand over its data. Only when the IUCN-GIS was closed, were the databases given to the newly established 'government'-NGO "PACTO". Without an experienced GIS operator, the problems of matching databases and data-integrity could not be overcome. Finally all 'PACTO' –data were lost due to the destruction of its hard disk, by climatic circumstances.*

All these experiences resulted in some beautiful maps but most GIS laboratories could not produce the expected products for planning and management. Moreover, because the GIS data was collected only in some specific areas, and for specific purposes, it did not contribute to the creation of nation-wide data, necessary for general policies on the management of the park system or for national forestry policies.

The environmentalist philosophy of most NGOs complicated things even further. NGOs mostly decided to work on their own GIS capabilities instead of improving regional capacity and practical applications of the state forest administration. Because NGOs thought they should protect nature from the state and the market, realising this vision of forestry management often created enemies. GIS was used to monitor the correct execution of tasks of forestry officials and NGOs tried to prove the destructive effects of banana plantations for water quality and deforestation. NGO information management was considered suspicious by the forest official and there was a widespread sentiment that GIS would serve surveillance purposes towards monitoring their activities. This often resulted in negative reactions and boycott of NGO activity (Rodriguez, 1993).

> *The state forestry office was 'de-masked' in many GIS projects, when overlaying the borders of protected areas or land use capacity maps with the forest management permits. In the Central Volcanic Mountain Range, the FUNDECOR project 'discovered' that many permits were given within the National Park area (USAID, 1994), while in Tortuguero permits were given in areas with a 'lower land use capacity'. After field checks, this Tortuguero example even led to a court case against forest officials (Munting et al., 1996; CEE, 1993). Afterwards the Forest Office stopped handing over information on forest management plans.*

FUNDECOR seemed to be the only NGO that consequently could develop its GIS capabilities. With generous financial support and being linked to a different forest regulation 'model', FUNDECOR did not face the problems and conflicts other NGOs had with the state bureaucracy. FUNDECOR could develop its models in peace since it avoided the majority of the state reorganisation dynamics, working with the Forestry Office and seeking only to interact with the market mechanisms in the 'private realm'.

The first step was the development of criteria defining the intervention areas of FUNDECOR's activities. Instead of the capacity method, which was seen as 'only a field method for forest management', FUNDECOR designed a map with 'critical areas' threatened by deforestation. The areas were based on population pressure, roads and forestry permits, and were used to prioritise interventions. FUNDECOR showed the validity of their critical factors by correlating them to land use change. 'Critical areas' correlated well with 'deforestation' in the land use change maps of 1986-1992 (which they elaborated in 1994). FUNDECOR served as a 'middle man' between the private landowner and the Official State

bureaucracy. They helped to elaborate the legally required 'management plans' for the land owners, but also engaged in collective bargaining with the wood industry to improve prices through a system of selling wood in advance to the highest bidder. GIS was used to elaborate (field based) forest management plans, indicating trees to be cut or preserved for future harvests.

The GIS in FUNDECOR was first only seen as a tool to produce a specific product: the critical area map. Slowly however, it became clear that the maps would help in planning-discussions "with the data at hand". FUNDECOR became aware of the strategic importance of data. GIS generated data helped their negotiations with hydro-electricity companies, and with an investor in a large tourist project, to incorporate forest management and protection in their business plans. FUNDECOR showed that protection was profitable and that it was able to monitor the forests and 'spy how land use is changing'[17]. These models and applications of GIS clearly reflected the 'forestry regulation model'.

In summary we can say that in this period, the government stimulated GIS implementation for forestry regulation through NGOs. Although the intention of many NGO-GIS projects was to improve management of the state bureaucracy, the difficulties with data and expertise, and the differences in planning visions (of state and NGO) led to a stagnation of the implementation process. In general, GIS was more of an added extra (used for convincing donors of project continuation), than a structural and conscious part of the NGO projects. The exception was the USAID sponsored FUNDECOR project. The generous support of FUNDECOR slowly led to the implementation of GIS models that reflected the donors' aim: private forest regulation and design of measuring environmental services of forest management.

6.4 Monitoring the Markets: GIS for Future Markets and Carbon Fixation

6.4.1 Financial and institutional support for GIS projects 1994-1996

Having seen that in the period 1990-1994 GIS implementation was promoted through a fragmented NGO structure, in the second period, the support for GIS locations and models shifted. The second period described in this section starts with a change in government from Calderon (1990-1994) to Figueres (1994-1998). In this first, period the Figueres government promoted strong central state regulation of forestry. With this planning philosophy, central information management came back on the agenda. During the reorganisation, the Ministry of Natural Resources teamed up with environmentalist groups, to propose investments in a new

[17] NGO official (NGO5, 25-06-1997)

GIS for all information on Natural Resources, within the Ministry (MIRENEM et al., 1995). This proposal was part of a World Bank loan proposal for the environmental sector. Because of the continuing state deficit problems, and divisions in the governing party, the loan did not receive support in the National Assembly. Because the World Bank proposal will be discussed extensively in the next case study, it is now only important to signal that the proposal pleaded for central regulation and decentralised conservation projects, which would be executed through the Regional Offices of the Ministry, instead of NGOs. The government did create a central GIS Office in the Ministry.

Another important factor was the government's decision to unite the Park Service, the Forest Office and Wildlife Office into one Office for 'Conservation Areas'. In the newly established Conservation Areas Office, the reorganisation caused long deliberations on redefinitions of tasks and responsibilities. Finally, the divisions within the government party led to indecision regarding the overall plans. An important shift in the Figueres government approach occurred. While at first in favour of central regulation, later the Figueres government embraced more neo-liberal policies, promoting deregulation and privatisation. Institutional reform, together with the political indecision of the government resulted in a situation where there was no support for investing in the central GIS Office.

The Central GIS Office however, was not entirely stranded without financing (Table 6.5). In 1994, it had already secured a GIS project for the inventory of Green House Gasses, funded by the FAO before the change in government. The project was only really up and running by 1995, with a training program in remote sensing by specialists of the FAO. The goal of the overall project was to train state personnel to create a 1992-land use map.

While some NGOs continued to invest in GIS[18], only FUNDECOR's GIS had a major impact on the regulation of forests and parks. After its first evaluation by the USAID in 1994, FUNDECOR explicitly began to look at ways of making sustainable forestry economically interesting. In their search, FUNDECOR launched two projects in which the GIS capabilities were key. The first was a project that organised advanced payments on harvests of forests, under sustainable management regime. The second project was the carbon fixation project (CARFIX), in which prevention of carbon emissions (deforestation), and carbon fixation by forest growth, was rewarded with 'environmental service payments'. The new Figueres government embraced these projects as part of their strategy to promote 'green business'. The idea of carbon fixation was even promoted by the president himself during official Central American presidential meetings and presidential visits to the USA (ALIDES, 1994; Figueres,

[18] E.g. the INBIO and Guanecaste Conservation Area invested in aerial photography, but in the end, they use them only in part because funds lacked for their restitution. The forest capacity maps (made by the Tropical Science Center, with funds from the Neotropical Foundation), could not be used in digital form because of errors during the digital elaboration, and lack of funds for the cleaning up of the databases.

1992). The most important part of the project consisted of elaborating scientific methods of forest monitoring for environmental service payments. GIS played a crucial role in the calculations of carbon emissions and monitoring forest use (change) (FUNDECOR, 1995a).

Table 6.5 GIS projects and products (1994-1996)

Year	Project name	Main agents in project	Expected results	Status
1995	*the Project for Conservation and Management of Natural Resources in Costa Rica*' GIS for forest inventory Osa	Ministry of Environment & Energy (MINAE), NGI	National GIS topographical maps 1:50,000 Forest Cover Map	Not executed
1995	Future Markets Forestry	Ministry Environment and Energy, FAO	Forest maps & Training GIS Office	Executed
1995	CARFIX	FUNDECOR	GIS based harvest prediction	Executed
1995		FUNDECOR	Methods for Monitoring Carbon Fixation & 1996 Forest Cover	Executed

The support received by FUNDECOR showed that the Figueres administration was promoting 'sustainable development' of forest areas, through private regulation systems and its self-assigned role of being an example for 'green business' world-wide. NGOs with more preservationist goals received less support, while investments in the bureaucracy GIS offices were put on hold because of disagreements over reorganisations of intersectoral planning and environmental regulation within the government team (Chapter 7). This provides us with an understanding of how the government empowered different groups through projects, lobbying and institutional reform. We are now in a position to look at the consequences that this had for developing expertise and data, as an important input for actual GIS implementation on the work floor.

6.4.2 Expertise and data aspects of GIS implementation (1994-1996)

In this section we will briefly look at the data and expertise that was present in the different locations for GIS. The government support for FUNDECOR, instead of the Central GIS Office had far reaching consequences for GIS implementation. The GIS equipment of the Central Information Office of the Conservation Area System was bought through a project for forest land use, while the training was given by the FAO in 1995. In 1996, the personnel evaluated themselves as 'a fledgling GIS-group' that still had to receive more training.

That same year, the group was made responsible for all 'information systems', and a website (for which the information still had to be defined and which still had to be designed). It is not

surprising that the group felt overloaded with tasks. The idea was that all the regional Conservation Areas would deliver their data in standard formats on e.g. forest permits. The problem was that there were no definitions on standards. Moreover, the 'richer' regional offices that were receiving foreign donor support, saw central control as a threat to their independence and economic prosperity (Quiros, 1997). Finally, given that they were responsible for the 'official map' of the boundaries of the newly created Conservation Areas, they had to re-digitalise the many proposals over and over again, because it took the administration until 1998 to define the final regional borders. Although within the Ministry plans were made to use this technology (e.g. Fallas, 1995; MIRENEM, 1995), without the personnel, funds and motivation not a lot was done[19].

In 1994, the FUNDECOR office had one person working permanently on GIS in the Central Office (1995). The 'central' GIS was used for general monitoring of project activities and land use change, while the FUNDECOR also began with GIS use for forest management, in its regional field office. This GIS was used to implement new criteria for long-term sustainable forest management. The Tropical Agronomy Research and Education Centre (CATIE) assisted and trained the local personnel. The forest management criteria were adopted by the Forest Office, and later even by the World Resource Institute as an example of 'sustainable development' (FUNDECOR, 1994).

> *The 'forest management GIS' contained field information on timber production specifically indicating all commercially interesting trees in an area, with their size and location. Also field measurements of rivers and slope were included in the data gathering process. With criteria for the conservation of forest biodiversity, slopes and rivers, the GIS helped select the trees to be cut (maximum 60% of the trees of the species), and indicated certain trees as seedling trees, that had to be protected. In the field, trees that were within a certain distance from the river and over a certain slope percentage would be excluded from the harvest. The inventory of trees that could be harvested (following the application criteria in the field) was evaluated 'scientifically' by building a digital terrain model with the data about rivers and slopes. With the terrain model, criteria about maximum slope and distance to rivers could be applied again, establishing some areas for protection. With these data and long-term growth curves, a long-term management plan was made.*
>
> *While FUNDECOR's GIS expert (Obando, 1998) thought that only the technology made it possible to fulfil the exact legal criteria of the forestry law (of e.g. slope and distance to rivers), student research for this thesis suggested that due to technical problems of errors in*

[19] An expert on forestry issues defends the state bureaucracy explicitly and thinks that remarks on the limited technological capabilities were part of 'state-bashing' by NGOs and the private sector (U51, 5-03-1998). In fact there were a few projects in the state sector that tried to improve actual management and control of information on the ground through information systems, but these all became obsolete after the projects terminated (Quiros, 1997).

the measurement and models, GIS was not superior to simple field observation[20]. This was reflected in the problems encountered during discussions with technicians in FUNDECOR during the elaboration of the digital terrain model. When asked to evaluate the GIS generated map that had been created from his field inventory, the forester involved could not recognise any of the indicators from what he remembered from the field. He thought that GIS was sometimes causing confusion when rivers from the inventory would flow uphill in the digital terrain model.

Forest management plans had yet to be approved by the regional offices of the Ministry. The maps produced by FUNDECOR were always very easily approved by the Forest Office because as a professional of the NGO mentioned 'they look so good and are so well elaborated'. There was still no digital exchange of data, because 'the state office still had a long way to go to even start using GIS'[21]. FUNDECOR and other NGOs were sceptical about the regional offices: "... it will take ages before they even will start using this technology"[22], and , "…profound change is needed in personnel if they even want to try to understand the technology..[23]". These quotes suggest that, NGOs perceived their superior knowledge of GIS as reflecting an inherent superiority and modern vision of solving environmental problems.

What we have seen in this section, has been the importance of the discrepancy between the GIS capabilities in FUDECOR and the state. While FUNDECOR was able to develop its models into complex analysis for forest management and carbon stocks, the state office was still learning to work with it. This discrepancy played an important role the development of GIS and the acceptance of its models.

6.4.3 Actual GIS implementation (1994-1996)

We have seen that government intentions to support a Central GIS Office in the Ministry of Natural Resources stranded due to the stalemate within the government team over solving the economic crisis. This section will therefore focus on the GIS initiative that was successful in promoting new models for forest regulation. The difficulties in decisions on institutional reform within the Ministry of Environment and Energy did not withhold the Figueres

[20]Something that I don't agree with, because the field measurements, technology and its internal calculations carry so many compiled errors, that the final map can only give indications on locations of trees and their relative position (and thus helping to design forest operations). The GIS maps cannot indicate what the exact location of trees is in relation of rivers and slopes with precision of meters (as stipulated by law). The details of this argument go beyond the content of this book, but were studied by De Filippi & Dolci (2001) as part of this PhD-research. Their conclusion is that GIS cannot replace forest managers who measure and designate trees that are allowed to be cut in the field, nor the forest officials who control the application of the law.

[21]Several interviews with professionals form the FUNDECOR offices (NGO4, 27-06-1996; NGO5, 26-05-1997; NGO6, 25-06-1997; NGO7, 30-06-1997; NGO3, 9-07-1997).

[22]NGO GIS operator (NGO7, 25-06-1997).

[23]NGO GIS operator (NGO15, 12-5-1997).

government from promoting 'green business' through its political support for the FUNDECOR project. The overall support and the complex reorganisations within the Ministry of Environment and Energy also led to stagnation in data collection and training in the Central GIS. At the same time, FUNDECOR was developing its methods and 'models' of GIS, which had large implications for the future of forest regulation. If FUNDECOR's models would be adopted, it could imply changes in control over information reaching to the heart of forestry regulation organisation itself. It is therefore important to understand how FUNDECOR's models and perceptions of land use were built into its GIS models.

In the beginning, FUNDECOR used GIS as an important tool for developing monitoring systems of local forest management, in which FUNDECOR would serve as the forest manager for groups, or individual landowners (Hazlett & Lehmkuhl, 1994). The GIS was not only a tool for the management itself, but also a tool for attracting projects, building confidence and demonstrating the trustworthiness of data.

> *"When FUNDECOR began, we worked only for specific products. Later we became conscious of the value to be able to have fast en flexible data at hand..... The changes in the use of GIS are mostly a change in attitude towards it... The existence of a GIS has given us the possibility to say things with the data at our fingertips, showing real maps. This generates trust from those who relate themselves with FUNDECOR, and people in FUNDECOR can always come to me to get information on specific projects or regions"*[24].

With the data, collected during the forest inventories for the forest management plans, FUNDECOR was able to predict forest harvests over a ten-year period. Once the expected harvest was calculated, investors were able to speculate on timber. At the same time, the inventory assisted in the administration of selective felling, which (in the eyes of FUNDECOR), guaranteed 'Sustainable Forest Management'. Although the procedures could also have been done on paper, the GIS enormously speeded up the process and gave the project more standing and scientific prestige. International Certifiers gave FUNDECOR the first 'green certificates' for their high-tech management procedures in 1995, also lauding the GIS methods (SGS, 1998). The 'green certificates' increased the value of timber and thus the revenues for forest owners (and those speculating on future harvests).

FUNDECOR's creativity went even further. It combined the land use change map, a forest type map and growth rates to calculate the actual 'carbon fixation' of growing trees. The calculations also conversely included the prevention of 'carbon emissions', by avoiding deforestation (FUNDECOR, 1994). FUNDECOR stated that due to their intervention and management methods, they could reduce and even stop deforestation rates, turning forestry usage into sustainable forest practises. They illustrated this by showing satellite images of

[24] GIS operator (NGO7, 30-06-1997)

forest land use of the Central Volcanic Mountain Range between 1992 and 1996. This data indicated indeed that deforestation was slowing down. There was no 'forest loss' on land managed by FUNDECOR. This data was used at international discussions to convince the World Resources Institute, to accept FUNDECOR's methods and have them officially certified for use in the international negotiations on green house gas reductions. These could prevent deforestation and even stimulate growth (FUNDECOR, 1994). FUNDECOR's 'CARFIX-project' thus became one of the world's first, official 'carbon projects'.

Critical environmentalists rejected these claims on the grounds that any "management" of primary forests would cause irreversible damage and loss of biodiversity. They protested that by subsidising this activity, FUNDECOR was actually stimulating deforestation. FUNDECOR admitted that some biodiversity might be lost, but argued that they at least protected forests from conversion into pasturelands. Their primary goal never had been protecting biodiversity, but prevention of land use change[25]. "FUNDECOR probably has one of the most advanced cartographic systems in Central America, which is a vital tool in land use management" said Tattenbach, FUNDECOR Director, adding that much of the organisation's data is based on satellite images. The GIS is important because: "..our bottom line is to stop land use change". Although sustainable forestry is difficult to reach, FUNDECOR takes 'a realist' approach: "the biodiversity is healthier in a managed forest than in a pasture..." (*Ticotimes, 19-09-97*). The GIS and the built-in models thus reflected a specific 'vision of forest regulation'. By limiting the attention to land use change, the monitoring method was blind for biodiversity loss, or other damage due to forest management. More importantly, however, the GIS proved to be a powerful and legitimising tool for this specific vision on forest regulation.

The importance of FUNDECOR's success was its influence on the Costa Rican government. FUNDECOR's methods were welcomed by the Minister, who claimed that the state's forestry policy of the late eighties and nineties had been working. His argument was that subsidies had slowed down deforestation, and, if environmental service payments could be made instead, the trend would continue. The government decided to copy FUNDECOR's methods. These were also included in a new Forestry Law. Drawing the technological legitimisation to the policy was important, and with the satellite pictures in hand, it promoted several institutional reforms for a nation-wide system of environmental services (see also Castro, et al., 2000).

> *"The satellite interpretation shows that the forest cover is growing with 1000 hectares a year", claimed the Minister for Environment and Energy (Ticotimes, 18-07-97). While*

[25] Indeed, in the first documents of the USAID, it is explicitly noted that the goal of the FUNDECOR project was the full exploitation of the last commercially interesting forest areas left in the country (USAID, 1989).

deforestation had continued, natural regeneration and plantations were growing faster in the ACCVC. In the national press, the government heralded the carbon sales as a new National Symbol: "Just as the start of coffee growing in the last century, Costa Rica is now at a historical moment being the pioneer developing the sale of clean air, which can become a major foreign income generator" (Minister of Environment and Energy ,Castro, in Ticotimes 14-02-97).

Environmentalists also criticised the rosy future presented by the Ministry, because environmental field offices reported an increase in illegal logging and more deforestation (*Ticotimes, 25-07-1997*). CIEDES, a research-centre of the University of Costa Rica, challenged the FUNDECOR satellite interpretation: " the growth in forest cover they supposedly show consists mostly of either underbrush or tree plantations, neither of which replicate the ecosystems and rich biodiversity in primary forests" (Sanchez, in *Ticotimes 25-07-97*). And later:"..a fundamental issue in deforestation studies is that methodological processes for remote sensing interpretation must follow standards similar to those used in other parts of the world, so comparisons and discussions have a solid scientific base" (*Ticotimes, 22-08-97*).

The Minister replied: "I have the hypothesis that what we have seen in the Central Range is taking place all over the country" (*Ticotimes 29-08-97*). "The new law encourages people to see forests as a precious resource from which they can benefit economically, rather than as an obstacle to development that is best cut down", added Arias the president of the National Fund for Forest Finance (FONAFIFO) *(ibid.)*. The Minister was convinced that FUNDECOR's vision on forestry was a valid way forward to promote Costa Rica as an important player in the international discussion on green house gas prevention. He started to copy the FUNDECOR activities on the national (and international) level by implementing a monitoring system. To halt negative commentary from sceptics and follow 'international standards', he hired the same critics to do the national satellite inventory as will be described below.

6.5 Institutionalising GIS for 'Environmental Services' (1996-1998)

6.5.1Financial and institutional support for GIS projects

After the presentation of FUNDECOR's ideas for GIS use for the calculation of carbon sequestration, we can turn to the final period of this case study, in which we will see how the government copied FUNDECOR's 'market model' of forest regulation. This section describes how the government institutionalised the 'environmental service payments' and made them official policy, by designing the organisational and legal structure around the GIS-models, described in the previous period (see Figure 6.5). It supported specific sections of the state bureaucracy to collect the data and implement a GIS necessary for monitoring of the new forest policies.

One important step was the approval of a new Forestry Law, in 1996. This law reflected a partial privatisation and deregulation of forest management. Environmental Services were explicitly included in the Law. The payments would fall under the responsibility of the National Fund for Forest Finance (FONAFIFO). This fund was an 'Autonomous Institute', but its board of directors was dominated with representatives from the private forestry sector. The National Fund for Forest Finance (FONAFIFO) would pay an amount for 'environmental services', in exchange for an official guarantee (via the Conservation Area Office) from a landowner to use the forest in a sustainable manner[26]. The Fund would calculate the value of 'carbon credits' (or carbon bonds) from the guaranteed management plan of a specific piece of forest. These credits reflected the amount of carbon stored by new growth of trees and the prevention of carbon emissions by reversing deforestation trends. A new Office for Joint Implementation, which was a public/private hybrid, would market the carbon credits collectively at an international level (Box 6.3). International certifiers would validate the system through a random sample field check of forest management plans. Essentially what we can identify here is how the role of the state is to 'rubber stamp' the private forest manager's plans (via the Conservation Areas Office), and to guarantee the certification system (through FONAFIFO). It especially demonstrates the acceptance of the market paradigm for forest regulation.

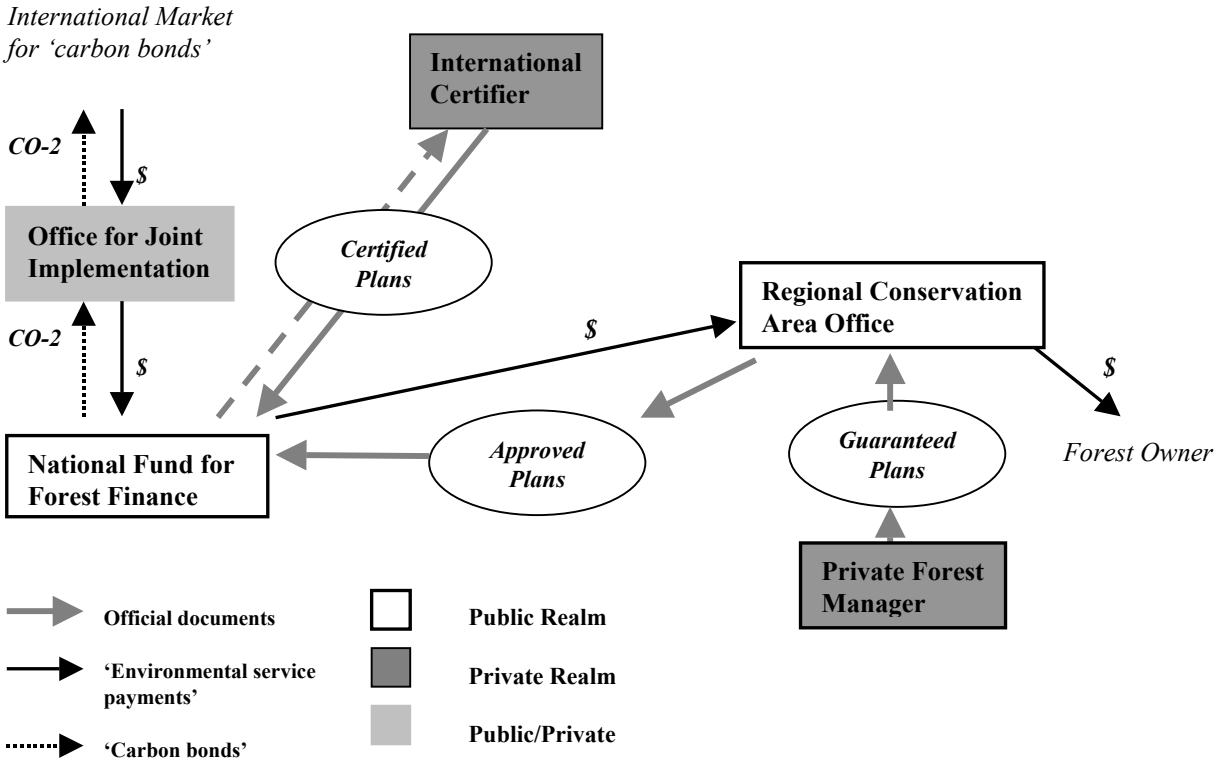


Figure 6.5 Institutionalisation of Environmental Service Payments

[26] If a landowner were found to be cheating he would face legal charges and would have to reimburse the Fund.

With this new model for environmental service payments, the Costa Rican government intended to become an important player in the discussions around the Kyoto Conference on Climate Change. That strategy certainly had benefits in terms of donor funding for projects. The initial projects for greenhouse gas reduction through schemes of 'Joint Implementation' were primarily developed with the USA. Although at first especially energy projects received funding, the expectations for forestry projects were high (Box 6.4). Through the system of environmental payments for forest management, the Joint Implementation Office was able to experiment in 1997 with the marketing of 'Greenhouse Gas Emission Mitigation Certificates', which had previously been referred to as 'carbon bonds'. As early as 1997, these bonds were marketed on the Chicago Stock market, with the help of the Earth Council and Financial Product, USA (*Ticotimes 16/5/97*; *la Nación 1/09/97*).

Box 6.3 Institutionalising the carbon market

Environmental Service Payments

The amount of money paid to each landowner was supposedly based on the alternative use (cattle) of a piece of land (Castro et al, 2000). The average amount necessary to convince a landowner to transform grasslands into forests was calculated US$50/ha. This amount had been paid by projects under FUNDECOR management (see above). Still, the Forestry Fund presented higher environmental service payments, giving the highest reward for forest plantations. In general there was more demand for the payments than the Forestry Fund could distribute, making the priorities of areas politically charged.

Table 6.6 Environmental Service Payments by the National Fund for Forestry Finance

Activity	Amount US$/ha.	% / Year				
Conservation	210	20	20	20	20	20
Reforestation	550	50	20	15	10	5
Forest Management	340	50	20	10	10	10

source: FONAFIFO (1997); www.fonafifo.com (April 2002).

The Office for Joint Implementation

The "Costa Rican Office for Joint implementation" (OCIC) was founded by the Ministry of Energy and Environment, the Export Promotion Office (CINDE), FUNDECOR and the Association of Private Electricity Companies (Diaz, 1997a; Ticotimes, 19-09-97). The Office for Joint Implementation was based in the office for Export Promotion (CINDE) providing good ties with the private sector. The board Director of the FUNDECOR, Tattenbach, also became board member of the Joint Implementation Office, and later became the most important negotiator for Costa Rica in the international discussions on climate change. The Office evaluated proposals and helped with the formulation of projects. It gave advice to the government and promoted international participation once a project was approved by the Office (OCIC, 1997). By establishing a 'single window' that would collect and coordinate all carbon offsets, project costs of the carbon bonds decreased, standardisation was guaranteed, while at the same time, the credibility of the carbon bonds was increased (IISD, 1998).

Until 1998, Costa Rica received around US$ 9,000,000 in international donor money to elaborate the institutional embedding and projects that would validate these ideas. The experiment was seen as strategic for convincing other countries at the Kyoto Conference on Climate Change to accept forest management as a means of reducing green house gases. The 'carbon bond' system would show the feasibility of a 'Clean Development Mechanism', in which rich countries could invest in green house gas prevention through projects in poor countries, where the cost of emission reduction would be much lower (*Ticotimes 12/9/97*; Box 6.4).

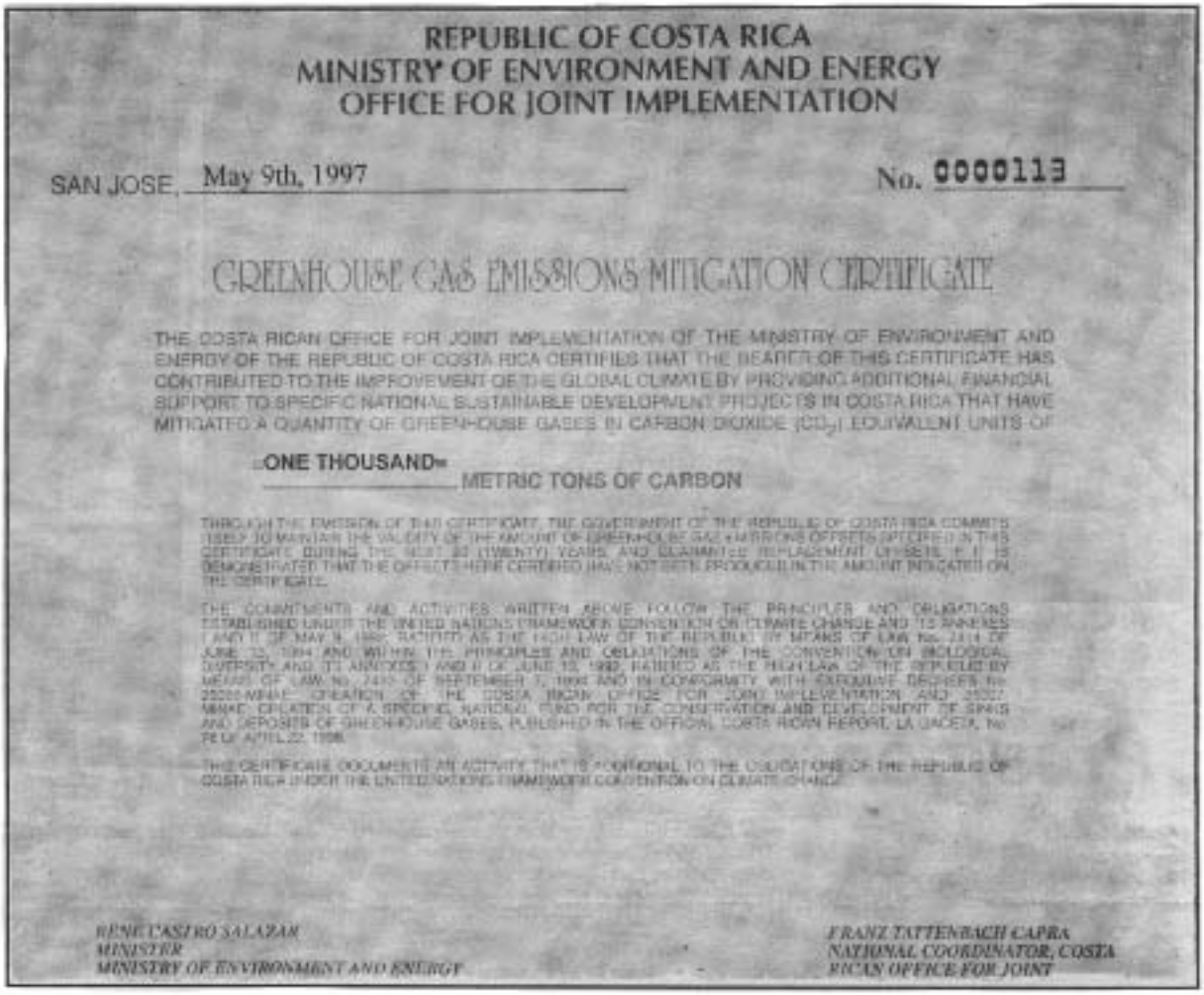
Box 6.4 Mutual benefits: Costa Rican - American Relations

In 1994, the government promoted the declaration for the cooperation between the USA and the Central American Countries. Cooperation included legal environmental reform, renewable energy and sustainable development (ALIDES, 1994). The declaration states that "..the USA will improve and coordinate GIS use... support and train for systematic surveillance through analysis of information from satellites..on [natural resources]. Central America will improve the legal system to monitor deforestation...". Together they "..will develop projects on ... forestry to fix carbon..." (ALIDES, 1994). The warm relations with the USA culminated in the visit of president Clinton in 1997 to Costa Rica. During a visit of the Conservation Area of the Central Volcanic Mountain Range (and wearing a "FUNDECOR" baseball cap), Clinton thanked Figueres for showing a 'real rain forest'. Conservation, joint implementation and bio-prospecting were lauded and Clinton underlined "..from electric buses, to wind driven power plants, the ambitious plans of Costa Rica show that we can have clean air and renewable energy sources, that create jobs here and in our country" (Ticotimes, 16-05-97). Costa Rica was able to secure 8 out of the 15 projects that were internationally approved by the United Nations Office for Joint Implementation (Michaelowa & Greiner, 1996).

Table 6.7 Joint Implementation Projects up to 1998 and proposed in 1999

Type	Land of origin	Amount US$
Renewable Energy	USA	90,000,000
Forestry	USA and Norway	8,100,000
	GEF	500,000
	Earth Council	376,000
Agriculture	The Netherlands	1,000,000
Research NASA	USA	?
Harvard	USA/BCIE	?
Proposed Forestry	To be marketed	?
Proposed Parks (1999)		180,000,000
Approved Forestry (2000)	World Bank-GEF	8,000,000
	World Bank loan	32,000,000

(sources: www.cinde.or.cr/inv_opp/inv_environmental_m.html (november 2000); www.unfccc.int/program/aij/aijact99/criusa04-99.htlm (november 2000); www.unfccc.de/fccc/aijact/crinor01.htm (august 1999); World Bank, 1998; Resor & Salloum, 1999; Camino et al., 2000)



REPUBLIC OF COSTA RICA
MINISTRY OF ENVIRONMENT AND ENERGY
OFFICE FOR JOINT IMPLEMENTATION

SAN JOSE, May 9th, 1997 No. 0000113

GREENHOUSE GAS EMISSIONS MITIGATION CERTIFICATE

THE COSTA RICAN OFFICE FOR JOINT IMPLEMENTATION OF THE MINISTRY OF ENVIRONMENT AND ENERGY OF THE REPUBLIC OF COSTA RICA CERTIFIES THAT THE BEARER OF THIS CERTIFICATE HAS CONTRIBUTED TO THE IMPROVEMENT OF THE GLOBAL CLIMATE BY PROVIDING ADDITIONAL FINANCIAL SUPPORT TO SPECIFIC NATIONAL SUSTAINABLE DEVELOPMENT PROJECTS IN COSTA RICA THAT HAVE MITIGATED A QUANTITY OF GREENHOUSE GASES IN CARBON DIOXIDE (CO_2) EQUIVALENT UNITS OF

ONE THOUSAND=
METRIC TONS OF CARBON

THROUGH THE EMISSION OF THIS CERTIFICATE, THE GOVERNMENT OF THE REPUBLIC OF COSTA RICA COMMITS ITSELF TO MAINTAIN THE VALIDITY OF THE AMOUNT OF GREENHOUSE GAS EMISSIONS OFFSETS SPECIFIED IN THIS CERTIFICATE DURING THE NEXT 20 (TWENTY) YEARS, AND GUARANTEE REPLACEMENT OFFSETS IF IT IS DEMONSTRATED THAT THE OFFSETS HERE CERTIFIED HAS NOT BEEN PRODUCED IN THE AMOUNT INDICATED ON THE CERTIFICATE.

THE COMMITMENTS AND ACTIVITIES WRITTEN ABOVE FOLLOW THE PRINCIPLES AND OBLIGATIONS ESTABLISHED UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE AND ITS ANNEXES I AND II OF MAY 9, 1992, RATIFIED AS THE HIGH LAW OF THE REPUBLIC BY MEANS OF LAW No. 7414 OF JUNE 13, 1994 AND WITHIN THE PRINCIPLES AND OBLIGATIONS OF THE CONVENTION ON BIOLOGICAL DIVERSITY AND ITS ANNEXES I AND II OF JUNE 13, 1992, RATIFIED AS THE HIGH LAW OF THE REPUBLIC BY MEANS OF LAW No. 7416 OF SEPTEMBER 7, 1994 AND IN CONFORMITY WITH EXECUTIVE DECREES No. 25705-MINAE, CREATION OF THE COSTA RICAN OFFICE FOR JOINT IMPLEMENTATION, AND 25027-MINAE, CREATION OF A SPECIFIC NATIONAL FUND FOR THE CONSERVATION AND DEVELOPMENT OF SINKS AND DEPOSITS OF GREENHOUSE GASES, PUBLISHED IN THE OFFICIAL COSTA RICAN REPORT, LA GACETA, No. 76 OF APRIL 22, 1996.

THIS CERTIFICATE DOCUMENTS AN ACTIVITY THAT IS ADDITIONAL TO THE OBLIGATIONS OF THE REPUBLIC OF COSTA RICA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE.

RENE CASTRO SALAZAR
MINISTER
MINISTRY OF ENVIRONMENT AND ENERGY

FRANZ TATTENBACH CAPRA
NATIONAL COORDINATOR, COSTA RICAN OFFICE FOR JOINT

Figure 6.6 Certified Tradable Offset (Carbon Bond) intended for the Chicago Stock Market (*Ticotimes 16 May 1997:11*)

Norway supported one such carbon bond project. To institutionalise the FUNDECOR methods for forest management, monitoring and certification, the government needed to implement GIS capabilities in a state institution. The implementation of 'a nation wide system for the sale of carbon bonds' was financed by Norway. The Norwegian project funded a new pilot area, and investment in 'national institutional strengthening'. This included a forest cover map elaborated on the basis of satellite images. The project was channelled through the National Fund for Forest Finance (FONAFIFO). The government also received donor support for the certification studies, completing a convincing institutional setting. The Norwegian project included the establishment of a GIS for forest monitoring in the National Fund for Forest Finance. Although the Office for Conservation Areas considered itself as responsible for forest monitoring, the government did not finance any project through this office. The National Fund for Forest Finance decided to hire private consultants (instead of the Office for Conservation Areas) for the elaboration of the 1996 Forest Cover Map.

The decision to give the National Forestry Fund the responsibility for the Norwegian project reflected the government's intention to stimulate a 'green business' approach to forestry. The fact that the project was elaborated through the Forestry Fund (instead of the through Conservation Office) indicated a choice for a market approach to forest regulation. It also reflected the private sector's influence on government projects and plans. By 1998, with the new institutional setting slowly consolidating, the government proposed two projects for the sale of 'carbon bonds'. The first, the Private Forestry Project[27], included funds for the National Fund for Forest Finance (FONAFIFO). As part of its official new tasks, the Fund would elaborate a regular update of forest cover studies, and monitor 'the environmental services-subsidies', through a GIS based administrative system. The second complementary project was the Project for Protected Areas (PAP). It included GIS implementation in all Conservation Areas for the administration of land registry and monitoring of forest conservation. The Protected Area Project was to do a satellite study every three years to monitor forest cover in parks, complemented with field visits by an international certifier (SGS, 1998). The project document was not specific about the use of GIS in the Conservation Area Offices except that it was expected to contribute to the 'general administration'. Although no explicit mention was made of GIS, we could interpret from the document that "good administration" was meant to be: land delimitation and tenure, fire fighting, patrolling routes, tourism[28]. The two projects reflect the government's intention to separate the responsibility for conservation from the responsibility for forest management and logging. These projects underlined that forestry was seen as a predominantly private sector activity and preservation was perceived as to be limited to national parks.

Table 6.8 GIS projects and products (1996-1998)

Year	Project name	Main agents in project	Expected GIS related results	Status
1996	*Norway project*	National Fund for Forestry Finance	FONAFIFO-GIS Digitalised management plans	Partly Executed
	Sub-project forest cover	CIEDEC, CCT	1996 Forest Cover	Executed
1998	Private Forestry Project (PFP)	National Fund for Forestry Finance	Digital management plans, Forest cover 1998	Not Financed
1998	Protected Areas Project (PAP)	Conservation Areas Office	GIS support Conservation Areas	Not Financed

[27]FUNDECOR would maintain an important role in training forest managers in GIS methods and certification programs.

[28] www.unfccc.int/program/aij/aijact99/criusa04-99.html visited in January 2000.

6.5.2 Expertise and data aspects of GIS implementation (1996-1998)

At this point we have an overview of the government projects and support for the institutionalisation of GIS for monitoring a market model of forest regulation. We have to look at what expertise and data existed in different GIS locations of the forestry sector. As we will see later, these data and expertise aspects were important resources in the actual implementation process.

For the Forestry Fund, GIS was seen as a necessity for monitoring the 'environmental payments'. To have the data at hand would facilitate being 'instantly accountable to the sponsors of the initial carbon bonds projects'[29]. To calculate carbon fixation, the National Fund for Forestry Finance decided to collect data for the complex calculations through consultancy contracts. Based on FUNDECOR's models, their GIS needed information on land use change, the 'life zones' (an indication for forest types), and the contract area under service payment schemes (CCT, et al., 1998). "Satellite images, ground truth-ing and independent audits ensured that the submitted information reflects reality" (UNFCCC, 2000).

The discussions on the interpretation of the FUNDECOR project's satellite images that we have explored in section 6.4.3, showed the importance of this technology as proof for land use change, and for legitimising the government forestry subsidy. Project documents that later elaborated on the FUNDECOR models reflected high expectations from satellite images (UNFCCC, 2000; Alpizar et al., 1996). The images were presented as giving a clear picture of actual deforestation and forest management. The definition of "forest" in the new Forestry Law as "areas of 2 hectares", also suggested the (future) use of satellite images to monitor these areas, because 2 hectares reflected the minimum area that still could be perceived by satellite. Therefore, the elaboration of these images and their establishment as a minimum observation unit were of strategic importance.

As we saw during the period 1994-1996, the Conservation Areas Office perceived its own experience and training as an important asset and proposed to elaborate the new forest cover map together with the Meteorological Institute and the CATIE. Preliminary talks were held about financial support from the Intersectoral Committee for Land Use Planning (TERRA)[30]. The Conservation Areas Office was highly disappointed, when the Minister decided not to support its proposal. Instead, as we already mentioned, he gave the contract to the Tropical Science Centre (CCT) and the University Centre, CIEDES, that just had criticised the plans. The way in which the data collection was arranged, delayed the actual implementation of the GIS of FONAFIFO.

[29] GIS expert Forestry Fund (FONAFIFO) (AI9, November 1998).

[30] TERRA meeting notes, 7-09-97

A member of the Conservation Area Office suggested that the reason for hiring consultancies for the satellite interpretation was that the director of the Conservation Area Office in the Ministry had very friendly relations with the Tropical Science Centre, of which he was the former director[31]*. The whole study was also 'certified' by 'Conservation International-Costa Rica', which shared its office and many projects with the Tropical Science Centre. This did not help to prevent suspicion of more friendly relations among the contracting partners. The National Fund for Forest Finance (FONAFIFO) replied this criticism by claiming that; "the Ministry contracted CIEDES to perform the [forest use] update because they are the best" (Ticotimes, 29-08-97).*

The consultancy project done for the Ministry by the Tropical Science Centre and the University Centre, CIEDES, delivered not only the forest cover study, but also a digital version of all areas under forest management and plantation contracts. The information was elaborated from information collected from the Regional Conservation Area Offices. With the data, the GIS of Forestry Fund started functioning. One person, trained as a forester with some GIS experience, became the responsible for the laboratory. The data that were finally received were not useful because of errors in the exact locations of the forest management plans. Because the errors were discovered only after the consultancy project had ended, the Forestry Fund could not retract the end result.

The digital information of the forest management plans and plantations, made by the Tropical Science Centre 'was a mess', with locations sometimes displaced with some kilometres, while others were overlapping. Part of the problem was that there is no good land registry with all land titles. "We only discovered it three months after the consultancy contract ended, so we could not reclaim it afterwards. Now we have to do the work again ourselves.."[32]*. The Fund decided to work directly with the Regional Offices. Even if it could be difficult to receive information, "..if you know the right person, they will hand over everything*[33]*". The National Fund for Forest Finance (FONAFIFO) also promised a digital version of the maps in return. The Regional Offices were from their side interested in cooperating with the FONFIFO, because they not only received a assistance with their own GIS implementation, but also FONFIFO was the hand that fed the subsidies.*

During the consultancy project, the Central Office for Conservation Areas was asked to hand over information on forest management. The obstacles in getting information from the Regional Conservation Areas Offices, put the Central Office in a difficult position. While the Regional Conservation Area Offices did not deliver information as a way of delaying central regulation, the government pressured information delivery for the strategically important Forestry Fund. As we have already mentioned, many NGOs and the National Fund for Forest

[31] Ministerial official (M27 , 02-11-97)

[32] Official FONAFIFO (A8, November 1998).

[33] Official FONAFIFO (A8, November 1998)

Finance treated the Central Office with suspicion. Slow delivery only compounded this. They accused the Office of 'incompetence and secrecy'. "They work full time with three persons, but they never seem to be able to finish the simplest map of the administrative borders of the Conservation Areas...[34]" or .."first they received all information from the regional offices but later they tell lost all the information..[35]". The GIS office admitted that they sometimes did not want to cooperate because "..they also don't give us their information.." and "...when they get paid for it, they should do the job themselves.."[36]. Here we see again how information was an important and contested element in GIS implementation. How these 'resources' were used, together with the financial and institutional support, for building actual GIS models, will be described in the next section.

6.5.3 Actual GIS implementation (1996-1998)

This section describes how these resources, together with the data and expertise aspects lead to stimulation of specific models and information in the GIS. Since we have established an overview of the projects that stimulated GIS implementation, and the generous institutional support for the National Fund for Forestry Finance, we are now in a position to look at how these factors influenced GIS implementation in the Forestry Fund.

The GIS project of the Forestry Fund was implemented under extreme time pressures, given that the intention was to use the outcomes for presentation at the Kyoto conference (and for many meetings around this conference). Many persons interviewed mentioned this as a reason for hiring the consultants from the Tropical Science Centre. The time limitations also led to the fact that the forest cover map only consisted of two categories: forests and non-forests. This limited the practical usefulness of the product enormously. Finally, the time pressure also led to difficulties in producing nation-wide data of high quality standards.

Immediately after the publication of the satellite study results, the maps were debated extensively in the newspapers. Environmentalists claimed that the map included fallow lands, and brush under the 'forest' category, and complained it did not distinguish between primary, intervened and secondary forests. The Conservation Areas Office was also critical: "They only used forest and non-forest categories, and will probably overrate the area...because that is what the Minister needed.."[37]. The Conservation Areas Office complained that they were not involved in the consultancy, and explained that this meant that they could not bear any responsibility for the quality of the project. The Conservation

[34] Interview with GIS specialist in NGO (NGO51, November 1998).

[35] Interview with official from the Forestry Fund (FONAFIFO) (AI8, November 1998).

[36] Interview with Ministerial Official (M27, 2-11-1997).

[37] Ministerial Official (M27, 2-11-97)

Areas Office pointed out that a 1986 study on the forest cover that was used as a reference year for the new cover map, had overseen the seasonal forests deciduous characteristics of the dry Guanecaste area. Therefore, no comparison could be made for the Guanecaste area, whereas in the new study in 1996, 'suddenly' a large area of forests had appeared. Although the map was used in many presentations, the area that was not studied was 18%! (Box 6.1 and Box 6.5).

Box 6.5 Scientific Forest Cover Inventories?

The consultants claimed a deforestation rate of 16,000 ha a year from 1986 to 1996, while through recovery of other areas net deforestation had fallen to 3,700 ha a year (CCT, et al., 1998). They also emphasised that the study only made an inventory of forest cover, including plantations and secondary forests. Compared to an earlier study by the same consultant (Sanchez, 1996) in which he found rates of 45,000 ha/year over the period 1986-1992, the rate is very low, showing the ongoing difficulties of interpreting forest cover with this technology (see also Holmgren & Thuresson, 1998). It is disturbing that these large discrepancies are never discussed in any of the scientific articles surrounding the land cover and climate change programs in Costa Rica, because they have direct implications for the feasibility of the monitoring process and the resulting differences in carbon estimates (e.g. Castro et al, 2000; Kerr, et al., 1999 & 2001; CCT et al., 1998; Leclerc & Hall, 2000; SGS, 1998; Laake, 1999, see also Box 6.1). Most authors (of whom many are involved in the GIS business) claim uncritically that satellite images are very useful in monitoring and recommend continuing with more of the same.

Proponents of the carbon bond system recognised that there were some problems. But the system, however flawed, was precisely what the carbon bond lobbyists needed to underline the excellence of their approach to forest regulation and management. The 'scientific-ness' was guaranteed because ‘the study had followed NASA-methods’, and met with ‘international standards’ (*Ticotimes, 20-03-98*). They presented the results as scientific support that would convince the market (and politicians) of the feasibility of the 'carbon bond' idea: "We want these Certified Tradable [carbon] Offsets to be of the highest quality because the market is about to open: we must establish the greatest credibility" (head of the Office for Joint Implementation, Tattenbach, in *Ticotimes, 01-09-1997*). The Minister needed to present the, in his words, "most thorough study of its kind carried out in Costa Rica" (*Ticotimes 6-03-98*), to the Intergovernmental Panel for Climate Change, to show Costa Rican achievements, and as a part of the certification of the carbon 'sequestered' in Costa Rican forests (idem).

Not only the “science” of the cover maps were questioned however. More importantly, some scientists and environmentalists argued that the whole calculation of carbon bonds was based on false premises (Box 6.6). The issues of whether the “science” could or could not prove calculations related to the carbon discussions, were fairly irrelevant in light of the gigantic international lobby and pressure from wealthy countries in the North which were promoting

adoption of forest management and conservation as a means of buying off emission reduction obligations (CEO, 2001; Lohman, 2001). Some agreed outright that the calculation was strategically more important than its real validity in the field. The Costa Rican example and success story was very useful for the international lobby to get the proposals approved during the Kyoto Conference. This was not because of its real scientific proof, but more because of its pretences to that end. The Costa Rican Forestry Fund GIS implementation appeared to be more of a study to find legitimacy (and project money) on an international level, than that it was to convince the Costa Rican forestry sector of the validity of its models. Its priorities were found predominantly at this international level.

> *Ticotimes suggested that in Kyoto, the Clean Development Mechanism was approved because of the Costa Rican example. "..Costa Rica provided the technical side of the proposal", while "...the diplomatic muscle power of Brazil was required to ensure its success in the summit.." (Ticotimes, 01-03-98). Tattenbach, the delegate of Costa Rica in the preparing sessions for the Kyoto protocol (e.g. International Energy Agency, 1997),was time and again pushing the other countries to adopt the idea, because 'it would deliver additional revenues equivalent to that of an additional export' (for example, Tattenbach, in IISD, 1998). At the conference in The Hague in 2000, the Costa Rican President explains the important contribution of Costa Rica: "Maybe politically they will not agree, but scientifically we are right" (la Nación 24/11/2000).*

The most important difference between the environmentalist critics and the regulationist Office for Conservation Areas on the one hand, and the defenders of the market model on the other, was that the former perceived forest regulation as totally distinct from the latter. While for the environmentalists and regulationists, regulation included biodiversity concerns, and enforcement issues in the field, for the market model proponents regulation itself could only function through market mechanisms, and hence there was no need for details of forest use, forest quality or biodiversity loss. A rough estimate of forests was enough to show that forest cover was improving. More importantly, the nice colour maps were used to gain legitimacy in international fora, far from the difficulties of forest regulation enforcement in the field. All of this demonstrates how the choice to put forest monitory responsibilities in the National Fund for Forest Finance inferred a market model of implementation, reflexively supporting the vision of forestry management and model to achieve it.

The implementation of the GIS in the different locations described in this chapter, underlines that the Costa Rican government and the international donors gave priority to implementing GIS for monitoring the 'chain of production' towards carbon bonds for private forestry. The Conservation Office had to wait 'for better times' or until a large investor would want to buy into the Protection Areas Project. GIS was presented as a necessary technology to improve the administration and the monitoring capabilities of the Ministry. The projects and priorities

of the government and donors, however, were more focused on the urgent development of the monitoring system for 'carbon bonds'. More efforts went to research for international legitimacy and recognition, than to the actual GIS use for improved forest management on the ground.

Box 6.6 Calculations of Carbon Fixation

GIS was needed to calculate the national deforestation rates which were used for CO-2 calculations. For the proposed Joint Implementation projects for National Forestry (PFP) and Protection (PAP), some simple calculations were made based on deforestation rates from the land use change studies 1979-1992. Deforestation in 'strictly protected' areas, and outside these areas were differentiated for the two projects. A 'base scenario' was calculated through an overlay of the deforestation areas with a map indicating forest types (life zones). With this overlay the amount of carbon was calculated for each forest type. By using this base scenario, it was assumed that deforestation would continue at the same rate as in the period of 1979-1992. In the Protected Areas Project the idea was simple: in a prevention scenario, in which the state would buy lands inside the parks, the amount from the prevented carbon emission could be sold on the international carbon market. In the Private Forestry Project, the prevention of deforestation was calculated. Afterwards the amount of trees that would be harvested was translated in amounts of carbon and this was deducted from the 'prevention' amounts. Finally the growth of new trees was added.

There are large problems with the 'base scenario measurement'. First it was difficult to get comparable data of good quality (see Box 6.5). Second, as Kerr et al. (1999) mentioned, the deforestation rate varies over time depending on the specific development path of a country. These authors explained the drop in the rate of deforestation in Costa Rica by the transition from an agricultural based society in an industrial based one. Further they argued that deforestation varies depending on local ecological and social variables. "The fact that, even with the use of such additional factors, predictions will never be perfect is one the reason [that] the establishment of baselines will not be purely scientific and ultimately include purely negotiated elements" (idem: 30). Also it is difficult to measuring the effect of prevention of deforestation in one area, on forests in other parts of the world, and there is a danger that carbon fixed in forests today will be released later (Chomitz, 2000). Others point to the false claims that plantations and logging would prevent carbon emissions while most wood will end up in smoke (Lohman, 2001). Finally, there is the danger of the loss of sovereignty by developing nations over large parts of their lands and development paths if they sell their 'emission rights' (ibid.).

6.6 Summary and Conclusion

This chapter has described GIS implementation for forestry monitoring under the responsibility of the Ministry of Environment and Energy. The development of GIS methods for forestry monitoring shifted throughout the nineties, as a consequence of changing policies. Governments promoted GIS use in different locations, and we have seen how this led to a variety of applications. By the end of the nineties, GIS forestry monitoring was given to a new location to be incorporated into the realm of responsibilities pertaining to a new forest subsidy: 'environmental service payments'. GIS located in the National Fund for Forest

Finance (FONAFIFO), developed attractive maps and models that were internationally influential as examples of forestry methods for green house gas reduction. But while doing so, it failed to meet its original aims of stimulating GIS for the improved administration of subsidies in local state offices at the field level. GIS implementation examined through the mainstream approaches would have failed to take into consideration the complex relations between organisations, shifting policies, models and applications of GIS.

Our technostructuration approach provided a means of explaining the shifts in support for different locations involved in GIS implementation for forestry policies. These different locations were linked to specific groups of forestry regulation, and promoted different 'models' of forest regulation reform. This had also consequences for the use of GIS and its applications. In the beginning of the nineties, for example, the state promoted GIS use in NGOs for management of Conservation Areas. The GIS applications were focussed on field level monitoring of forests, state forest bureaucrats as well as logging companies. This reflected the environmentalist idea that nature had to be protected against the state as well as the private sector. The GIS models developed around 1994, by the 'market oriented' NGO, FUNDECOR, were reflecting the idea of a deregulated forestry sector. GIS was used for calculating and monitoring the environmental service of forests as 'carbon sinks'. This last model was taken up by the Figueres government in 1996 and strongly supported by international donors. GIS was perceived as of strategic importance for the nation-wide institutionalisation of the environmental service payments, as well as for convincing the international community of the Costa Rica example for trading these environmental services as carbon bonds between rich polluting countries and the Third World. GIS implementation itself was also influenced by institutional settings. The proliferation of NGOs in the early nineties meant that information was produced locally, in an uncoordinated manner , often in secrecy. The market approach, of the late nineties, led to a more flexible approach to consultancy contracts. This speeded up the implementation of GIS, but also resulted in a situation where the products could not be verified on the basis of quality. This explained in part why the GIS of the Forestry Fund could not pay attention to local administrative GIS applications. More importantly however, was the overall focus on the aesthetic use of GIS for presenting Costa Rica as a showcase around the international discussions on Climate Change in Kyoto. Regardless of the real scientific value of the models, the Costa Rican example was presented with great pomp and circumstance. GIS attributed trustworthiness, scientific objectivity and legitimacy to its user. GIS and satellite use resulted in less attention to qualitative cover changes. Changes to biodiversity were not monitored, nor were impacts of logging. Priorities for forest policy and subsidies were based more on market forces and donor preferences (in which area does an investment give the highest rate of environmental services), than on knowledge of forest value, biodiversity or social factors. The limitation of 'forests' to 'areas with trees' was profoundly anchored in both GIS, and the legal conditions of forestry management in which it played a role.

7

A National GIS for "Ordenamiento Territorial"

Introduction

An important part of the Agenda 21 document from the Rio Conference in 1992 pointed to the need for intersectoral and environmental planning. The documents called for "…the necessary institutional change, ...to achieve the integration of environmental and developmental information…"(UNEP, 1992: 40.10). The use of GIS and digitisation of information was seen as a strategic and necessary step to improve availability of information for decisions on sustainable development (UNEP, 1992). This chapter describes the long search for institutional reform of the Costa Rican National Geographical Institute into a National Geographical Information System, which would serve internationally promoted intersectoral and environmental planning goals.

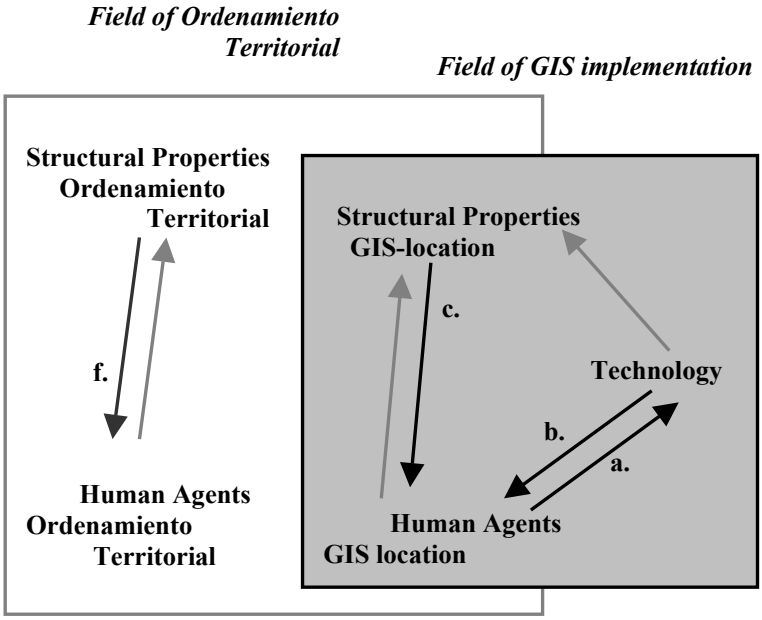


Figure 7.1 Techno-structuration of a national GIS in the forest sector

a.& b. GIS implementation as a negotiated process by human agents
c. The influence of data and expertise on GIS implementation process
f. The influence of planning and policy priorities on the promotion of projects of GIS implementation
(arrows in grey will be dealt with more extensively in the last chapter)

Subsequent governments, however, envisioned the creation of this National Geographical Information System in different ways, proposing different locations for GIS, and for the way it should contribute to planning. While in the nineties 'planning' had become 'a dirty word', Latin American countries coined the new term, "ordenamiento territorial", as a key state policy towards sustainable development (CDMAALC, 1990; Lücke, 1997). The term, which means 'spatial ordering', has connotations of regional planning, regulation and zoning. In the Costa Rican context the term was sometimes presented as 'a functioning land registry' (COTI, 1993; Barahona, 1992) but in other contexts was officially translated as "national reorganisation" (Jansen, et al., 1994:194). With our 'tools' of the technostructuration approach (Figure 7.1), we will explain the different shifts and developments during the implementation of this envisioned National GIS for "ordenamiento territorial".

Similar to the forestry case, this chapter will explain how different government plans led to GIS implementation in different locations involved in intersectoral planning. It will also show how the existing structure and organisation of planning, and different perceptions on planning by different agents involved in the implementation process, strongly influenced the actual realisation of the GIS plans. This chapter is somewhat related to the previous chapters, in that developments of GIS in different sectors influenced implementation of a National GIS. The difficulties and many changes during the implementation of the National GIS will be often related to the earlier case studies. From a technostructuration approach, GIS implementation is reflexively related to changing organisations, rules and norms. This case study illustrates this more clearly than the previous chapters. This is because, from the beginning, GIS implementation was directly related to institutional reform in all the project documents. The final failure to change the institutional embedding of the National Geographical Institute, and frequent failed attempts to create a National GIS, can only be understood from the wider context.

To understand the complexity of National GIS implementation for the 'modernisation of the National Geographical Institute, (hereafter, NGI), we will first introduce the issues at stake in the 'field of intersectoral planning'. In this section, I also introduce the main interest groups, their visions and perceptions of planning as well as their information and GIS needs (section 7.1). Similar to the foregoing chapters, in section 7.2, I give a short interlude of the actual organisational embedding of the NGI during the nineties, and the proposals for moving the Institute to other locations that better suited the goals of an intersectoral National GIS. This short description will help us to understand the main political shifts influencing the NGI. It serves as a background to the periodisation used in the remainder of the analysis. In the first period (section 7.3), the Calderon government (1990-1994) envisioned the establishment of a National GIS that would support a multipurpose land registry, by merging the NGI and the National Land Registry. This new institute would assist intersectoral planning of the municipal governments with information services. During the Figueres administration (1994-

1998), policy (and projects) changed radically, towards centralising information into a National GIS (and the NGI) under the responsibility of the Ministry of Planning, or the Ministry of Environment and Energy (section 7.4). Sectoral resistance and divisions within the Figueres government led to the failure of this attempt.

I use the same subdivisions as in previous chapters to organise the section on the actual implementation of a National GIS. For every time period, I start with an overview of the political support for (prestigious) projects implementing a National GIS centre, together with the (proposed) institutional reform(s). After a discussion of the main data and expertise issues, in a second sub-section, I describe the actual implementation of the projects, as a negotiated and reflexive process of human agents with the institutional setting in which they operate. This chapter ends with a summary (section 7.5), and some concluding reflections on the relations between the case study chapters.

7.1 Intersectoral Planning and Decentralising Spatial Regulation

To understand the background discussions surrounding the creation of a National GIS and its institutional embedding, these sections will give an overview of the main issues concerning intersectoral planning in Costa Rica during the nineties. In the early nineties, attention for environmental issues reinvigorated the discussion on intersectoral planning and coordination of actions to stimulate 'sustainable development' (Lücke, 1997; Quesada, 1990). As mentioned in Chapter 1, it was widely expected that GIS would contribute to reaching sustainable development. In the Latin American context, the idea of 'ordenamiento territorial' (spatial planning) was proposed as an important way for governments to contribute to sustainable development (CDMAAL[1], 1990). It was hoped that by coordinating activities, the state would become more efficient and effective in executing future integrated land use plans and in enforcing regulations on land use (Lücke, 1995). Both governments (1990-1994 and 1994-1998) proposed several changes to the institutional organisation of "ordenamiento territorial", reflecting their visions on how to organise intersectoral planning. To understand what was at stake, I first will give a short summary of the main problems of planning in the Costa Rican context.

Throughout history, Costa Rica has formulated many laws that regulate aspects of land use. This has resulted in a degree of overlap between many ministries and state institutes. Cotera, et al. (1998), for example, mentioned 23 Ministries and Institutions that regulated part of the land use. The resulting planning landscape also created confusion between the Municipal governments and these 23 central state institutions (idem) surrounding 'who' should be responsible for 'what kind of planning' in 'which' institutional setting and at 'what' level.

[1] Comisión de Desarrollo y Medio Ambiente de América Latina y el Caribe

Urban planning was the task of the municipalities and the central state Institute for Housing and Urban Development (INVU[2]). Most attention went to Costa Rica's Central Valley, where all bigger cities were located. The governments tried in vain to plan this area through the Extended Metropolitan Area (GAM)-plan. The biggest problem was the coordination between individual municipalities on the one hand, and between the central state institutes (regarding responsibilities over roads, water, housing etc) and municipalities on the other. In general, the budget and power were centralised through the different central state institutes, but the municipalities were slowly gaining importance[3]. In the Central Valley, the urban 'sector' and the municipalities were relatively strong, while the rural 'sector' was loosing importance, complaining, for example, about the disappearance of fertile coffee plantations for housing projects, and environmental impacts of deforestation and pollution.

In the areas outside the Central Valley, regional planning was most commonly understood as 'rural development planning'[4]. In general, municipalities in these areas were weak and poor, while the 'rural sector' generated most income, labour opportunities and investments. The idea of regional planning was often related to the idea of stimulating 'backward areas' and redistribution of wealth in the country. The regional planning offices of the Ministry of Planning were therefore normally working closely with the Ministry of Agriculture. Most planning was done through the Ministries, and the municipalities only had some influence through their 'advice' to the 'regional development councils[5]'.

Throughout history, actual responsibilities for many land use issues were divided among different Ministries and sectors, while the coordination task for spatial and intersectoral planning was (if at all) the responsibility of the Ministry of Planning. The problem was the weakness of the Ministry in its 'regional planning' responsibilities and activities, especially after its regional offices closed in 1992 (Chapter 3). It also was hard to actually coordinate the two fields of urban and rural planning. Finally, the fast developing Ministry of Natural

[2]This institute fell under the responsibility of the Ministry of Planning, as did the Institute that assisted municipalities in developing technical capabilities (IFAM). The Ministry not only had to coordinate between these institutes, municipalities and e.g. the Ministry of Public Works and Infrastructure, but in the late eighties also a new Ministry for Housing was created as part of requirements for the Structural Adjustment Programs for more government control over resources. Even in 2002, the Ministry had not yet received the legal approval it needed from the Legislative Assembly. This situation has only worsened the 'coordination cacophony' in urban planning.

[3] As described in the Chapter 3, the Calderon government made proposals for the decentralisation of many tasks to the municipalities, while during the Figueres administration, tax reform was accepted giving (especially the bigger/richer) municipalities more income.

[4] This is not so strange considering the economic activities in these areas, but also because of the 'development and income divide' between the rest of the country and the Central Valley (PDR, 1997).

[5] After 1991, the municipalities lost influence when the Calderon government replaced a number of municipal council representatives with representatives from private businesses in these councils. The disappearance of the Regional Offices for Planning, in 1992 created a vacuum in coordination efforts (Chapter 3; Rivera, 1997).

Resources (created in 1986), claimed that intersectoral planning responsibilities were to part of environmental protection and sustainable development (Quesada, 1990).

The absence of trustworthy information aggravated the problems mentioned above. Information was often outdated or of the wrong scale, lacking or not available (Box 7.1). While officially the National Geographical Institute was responsible for all of Costa Rica's map making and a wide variety of data collection activities, in practice, (with the exception of topographic mapping), this task was actually delegated out to the sectoral institutes and Ministries.

Box 7.1 Problems of Information Availability

Because of the economic crisis during the nineties, Costa Rica postponed its National Census for 18 years. The last census in Costa Rica, prior to 2002, was held in 1984. This resulted in a complete ignorance of actual population and migration patterns, economic activity, schooling data, etc. In the cases where information was collected, it was on natural resources essential for 'diversifying the economy', (with studies on hydrocarbons, minerals and forests or in the Costa Rican case biodiversity). To deal with the information scarcity, few attempts have been made to generate approximations of poverty indicators, while population growth figures were generated on the basis of trends prior to 1984.

A 'diagnosis' for the planning of the 'Canton of Saripiqui' [a municipality in the northern zone] shows the consequences of the information problems (PDR, 1996). The Ministry of Health has estimated the population at 57,089. The Office for Statistics, however, indicated a mere 27,733. With a difference of over 50%, it was difficult to plan budgets for schooling, health, etc, or estimate e.g. (un)-employment. Although the figures were collected and published in a single volume, the data problem was not mentioned once, and no comparison or cross analysis was made. The Institute of Schooling, for example, only diagnosed problems of registered pupils who dropped out of school or they identified problems related to school facility maintenance, but they did not estimate the total percentage of children attending school. With the (more detailed, and probably more trustworthy) Ministry of Health figures, this would have been only 50%! Since the Costa Ricans are internationally renown for ranking among the highest education levels in Latin America, a comparison of these data would have given a different picture (at least for these rural areas).

In this planning landscape, with all of its coordination tensions and difficulties regarding the division of responsibilities, GIS was often presented as a long overdue 'wonder drug' technology. Governments in the nineties thought that GIS could play an important role in finding a solution to the coordination problems. GIS was seen as a way of integrating information from different sectors and scales (COTI, 1993). For example, information on land transactions in a remote municipality could automatically be transferred to a National Land Registry, or between different Registries[6]. Investments in information projects were

[6] In Costa Rica different registries exist for property registration (such as possession of land and houses), tax registration on these properties, and the exact location and maps of these properties.

therefore seen as both helping to get the right information, but at the same time as a strategic resource for the coordination of tasks and regulations. For this reason, in the nineties, there was an explosion of GIS proposals to assist national level land use planning and the different proposals on state reform for spatial planning. In other words, or 'ordenamiento territorial' had consequences for the organisation of a National GIS.

"Ordenamiento Territorial", as referred to in many government documents, restated the ideas of intersectoral and regional planning, with an emphasis on environmental issues. Originally, the discussion was pushed by the environmental movement and by technocrats from the state system. The environmental movement sometimes included solutions of more participation and democratisation. The wider state bureaucracy was also an important actor in the discussion, and while not against more intersectoral coordination, it has defended its own sectoral responsibilities. Reluctant to give up its original tasks they pointed to the necessity of technical expertise of the specialised (sectoral) state institutes.

In Chapter 3, we saw how throughout the seventies, there were significant problems concerning how to organise the coordination of land use planning tasks. Similarly, the ordenamiento territorial discussion in the nineties was also fierce and complicated. Three key questions came up during the discussions. First, there was the question of scale or the levels at which interventions should take place. Secondly, there was a question of which type of intervention should be featured. This was in fact a discussion of the different kinds of possible regulations, such as strong enforcement of zoning plans, subsidies and taxes, weak regulation, or market mechanisms. Finally, questions of coordination pitted the state bureaucracy against the government executive regarding the definition of who should be responsible for harmonising planning.

As we mentioned above, different groups in the state bureaucracy and government proposed different solutions and as a result, saw different roles for a National GIS in activities of ‘ordenamiento territorial’. It is now time to introduce the main groups and their visions on intersectoral planning (Table 7.1). The regulationists favoured rational scientific planning ideas, and proposed that the coordination of planning should be organised between the Ministries, but not too close to the president or executive, because that would make plans 'too political' and dependent on the electoral cycles. This group consisted of large parts of the state bureaucracy and groups of academics. The regulationists were mostly influential in the Autonomous Institutes, the Ministry of Agriculture and the Ministry of Planning. Pointing to the technical limitations of municipal governments, they thought that decentralisation to a municipal level was not (yet) feasible. There was to be a planning level in between the municipalities and the national Ministries for some form of ministerial coordination at a regional level. The Central Valley was envisioned to remain a special independent, and more urban region.

The idea of a central information system was not discarded, but they believed that the quality could only be guaranteed, and its efficiency would increase, if every sector would be responsible for the creation and updating of its own sectoral 'official' information. If a National GIS was to be erected, it should be in an independent reformed National Geographical Institute, that would coordinate and guide the efforts of the sectoral information offices. National GIS was to guarantee high quality information, available at the regional level, and through the integration of different sectoral information themes, it would become responsible for coordinating planning at different levels. This National GIS should be guided by a committee of 'purely technical people' from the sectoral Ministries.

Table 7.1 Visions on spatial planning and its consequences for GIS

GIS projects:	**Regulationists** DIPLUT/NGI (MIDEPLAN)	**Populists** Multipurpose Land Registry	**Market proponents** SISVAH Land Registry	**Centralists** TERRA
Intervention Areas	National Regional Municipality	Regional Conservation Areas, Municipalities	Municipality	National New Regional Division
Governance	Top-down	Participatory	'Dialogue'	Central Coordination 'consensus'
Inter/sectoral	Sectoral	Intersectoral	Sectoral	Intersectoral
Natural Resources	Public	Public/private	Private	Public/private Sovereign
Intervention	Master plans Differential Taxes	Environmental Impact Assessment Differential Taxes	Land and Services Markets	Creative Coordinated Projects
National GIS-use	Inventory & Planning, Regulation & Enforcement	Open GIS as Depository Local Plans and Regulations	Land Registry GIS Private Information Services	Inventory, Strategic Planning, Coordination

The second group can be identified as favouring more decentralised forms of planning and actual democratisation of decision making processes, putting environmental concerns at the heart of central planning coordination. The proponents of this position were predominantly populists and environmentalists (such as NGOs and state bureaucrats, linked to the Conservation Area System, the league of municipal governments[7], and small farmers' organisations). We can identify that this group was not against regulations or planning, but wanted local and 'civil society' participation in the formulation, execution and control of plans. Pointing to the weaknesses of municipalities, they wanted more financial means and municipal training, which could be realised (to a large extent) by actually transferring territorial tax collection to the local level. At the heart of this perspective, was planning

[7] This organisation and its members were still rather weak and often more reactive than able to formulate their own agenda for 'state reform' (Rivera, 1997).

reform towards a better functioning (instead of a corrupt) state with guarantees for transparency and democratic control. Some concrete proposals were that municipalities should build their cadastral services and formulate their regulation plans in a participatory way. On a higher level, civil society environmental committees should be allowed to influence the formulation, implementation and monitoring of actual regulations. They used the concept of 'the right to a healthy environment' as an intersectoral integrative term. In line with the planning vision of this group, information was to be publicly accessible, and environmental impact assessments and regulatory plans were to be controlled and executed at a local scale. This reflected the concern for local empowerment while doing justice to the variability of social and biophysical factors[8]. A National level GIS would consist of multipurpose land registry with land titles and the municipal regulation plans, as well as environmental impact assessments open to the public. Land property taxes should reflect the local land use capacity, and punish 'under-use'. Some small farmers' organisations suggested to use the existing expropriation laws to continue with land reform, in areas that were 'under-used' because this would prevent landless farmers from encroaching on fragile areas or move to the urban slums[9].

A third group can be identified as proponents of the 'market' paradigm. The proponents of market forms of planning equally used the term 'participation' and 'decentralisation' when talking about reforming the tasks of the state considering spatial planning. Unlike the populists and environmentalists though, this group interpreted the term 'participation' as competition where the introduction of market mechanisms for land use regulation could guarantee that the most efficient business would find the most efficient way to deliver the services of e.g. water and electricity. Deregulation of services, clear property rights and transparency (of the sometimes corrupted land market) were key to this vision of land use planning. This group consisted of parts of the Costa Rican business sector as represented by the Coalition for Commercial Development Initiatives (CINDE), the National Association for Economic Growth (ANFE) and the Chamber of Industry, together with the international financial institutes (World Bank, USAID, Central American Bank for Economic Integration, Inter-American Development Bank).

Those supporting the aforementioned planning vision, promoted a GIS for the National Land Registry as a priority (for improving the land market), and a separate GIS on Natural

[8]Brenes (1992) warned of rigid top-down approaches to standard planning methods. He mentioned for example, the use of elevated fertile micro areas for agriculture in the Barra de Colorado Wild Life Refuge by the local fishermen. Rigid application of the 'official' (1:50,000) land use capability classification would lead to classifying the area as non-agricultural areas. This would result in problems for land titling and the legal status of the property. As a result, the fishermen would be excluded from receiving assistance and credit from the state. If the proposals for a new tax system [at that moment in discussion] would be adopted, it would punish the farmers, tripling the 'normal' land tax for 'over-use'.

[9]Field notes of farmers meetings on 'ordenamiento territorial' (25-09-1997; 6-06-1997).

Resources, both publicly accessible. Following this market logic, land use decisions should be made on the basis of the individual landowners' considerations of profitability. If the state wanted to enforce some forms of zoning or regulation, it should preferably be done through market means of environmental services, and/or based on clear, transparent, technical criteria, applied through a simple procedure.

A fourth and final group can be identified as having nationalist, centralist and technocratic tendencies. This group wanted to improve the spatial planning by reforming its coordination into a small, technocratic planning body that would function close to the executive and the President. The assumption was that this could accelerate and improve the planning process while preventing bureaucratic obstacles. In the eyes of the centralist technocrats, the central coordination body should also regulate international projects and capital inflow[10]. Proponents of this planning vision can be referred to as "centralists". This group consisted of some academic technocrats and members of the Social Democrat Party elite, linked to the national business sector. They agreed with what we have identified as being the 'regulationist' group, in that a national technical institute should elaborate plans and set regulations. In contrast with regulationists, however, they wanted to avoid bureaucratic procedures and checks, increasing flexibility in (what they viewed as) a suffocating state system. Several advocates of this planning vision formulated a law proposal for the creation of a coordinating institute (Cotera, et al., 1998). The law pointed to the importance of 'participation' in land use planning. In the proposal, participation was to be guaranteed by involving the private sector in a national committee for intersectoral land use planning. It would serve as the board for this central regulatory institute. Regional business councils would be key in attracting investment for regional business opportunities. At the heart of this strategy was the idea that by involving the national industry and political leaders, 'indigenous' planning would guarantee sovereignty and national (co-)investments. Information was seen as neutral. Planning was expected to be intersectoral, but according to this group, it should start with the creative ideas of visionary leaders. Centralised information was seen as essential for the executive to make fast and flexible decisions. Proponents of this centralist approach envisioned a national GIS that was permanently updated, while planning itself would become a decentralised activity, coordinated through the information system.

In this section, we have looked briefly at the main players and issues at stake in the 'field of ordenamiento territorial' (Figure 6.1). With this overview, we now focus our attention on the various attempts to implement a National GIS. This section gave use the background for understanding government decisions on institutional change and specific GIS projects. It also provided the main 'institutional niches', existing in different parts of the state. The next

[10]As a response to neo-liberalisms, they proposed 'sovereign and national development' (Lücke, 1994; Dengo, 1977).

section will start with a short overview of a periodisation of changes in the actual and proposed location for a National GIS. After the periodisation, we will use the overview above to explain the various policies supporting a National GIS and the choices made during its actual implementation.

7.2 Organisational embedding of a National GIS

As we mentioned at the outset, attempts to implement a National GIS for 'ordenamiento territorial' can de divided in two periods. The coming pages feature an explanation of these periods. It serves as a tool for the reader towards understanding the complexities of GIS and institutional change.

The first period runs from 1990-1994, when the Calderon government initiated two large GIS projects. During this period, information generation for spatial planning reflected the market vision of land use regulation (through a functioning land market and taxes), and service delivery (water, electricity, but also digital information on these issues!). In line with the more private road to 'ordenamiento territorial', the Calderon administration perceived the National Land Registry as a multipurpose location, where data on land ownership, soils and municipal regulation plans could be bundled into a single organisation for effective administration of land for the entire Costa Rican territory. A second Geographical Information System for the Central Valley, SISVAH, was envisioned to assist municipal regulation plan elaboration and urban planning (Figure 7.2).

The second period is essentially the Figueres Administration's term in office (1994-1998). The Figueres government created a committee for the intersectoral planning coordination at a central level. This committee was called, TERRA[11]. It was given the task of defining the institutionalisation of a National GIS. In project documents, and during actual implementation, the difference between institutional reform of planning authority, and the National GIS, was often muddled. We can identify this confusion as reflecting the government's perception that GIS was essential for planning (Figure 7.2).

In both periods, administrations proposed to change the location of the National Geographical Institute. During the Calderon period (1990-1994), the idea was to merge the National Land Registry with the National Geographical Institute (NGI), reflecting ideas of efficiency (in terms of mapmaking, geodetic restitution technology and aerial photography). The Figueres government (1994-1998), however, tried to merge the NGI with the new

[11]The presidential decree that created this committee referred explicitly to the Agenda 21 agreements. TERRA would implement 'the part of agenda 21 that was concerned with GIS' (GOCR, 1995a). The name 'TERRA' also reflected the Agenda 21 program on environmental information 'INFOTERRA', which confirms the administrations' ideological link with international environmentalism.

(central) location for the National GIS. Official proposals for the final destiny of the NGI often changed. Proposals included a transfer of the NGI with the National GIS to the Ministry of Natural Resources[12], or to make a Foundation with the Urban Planning GIS (SISVAH), the NGI and TERRA. Yet another proposal was, to transfer the National GIS to an academic institution (CENAT). As we will see later, this reflected the disagreements and ongoing negotiations over the National GIS and its institutional embedding. Even long after the government change of 1998, the situation remained uncertain (with a contested move of the National GIS to the Ministry of Environment and Energy).

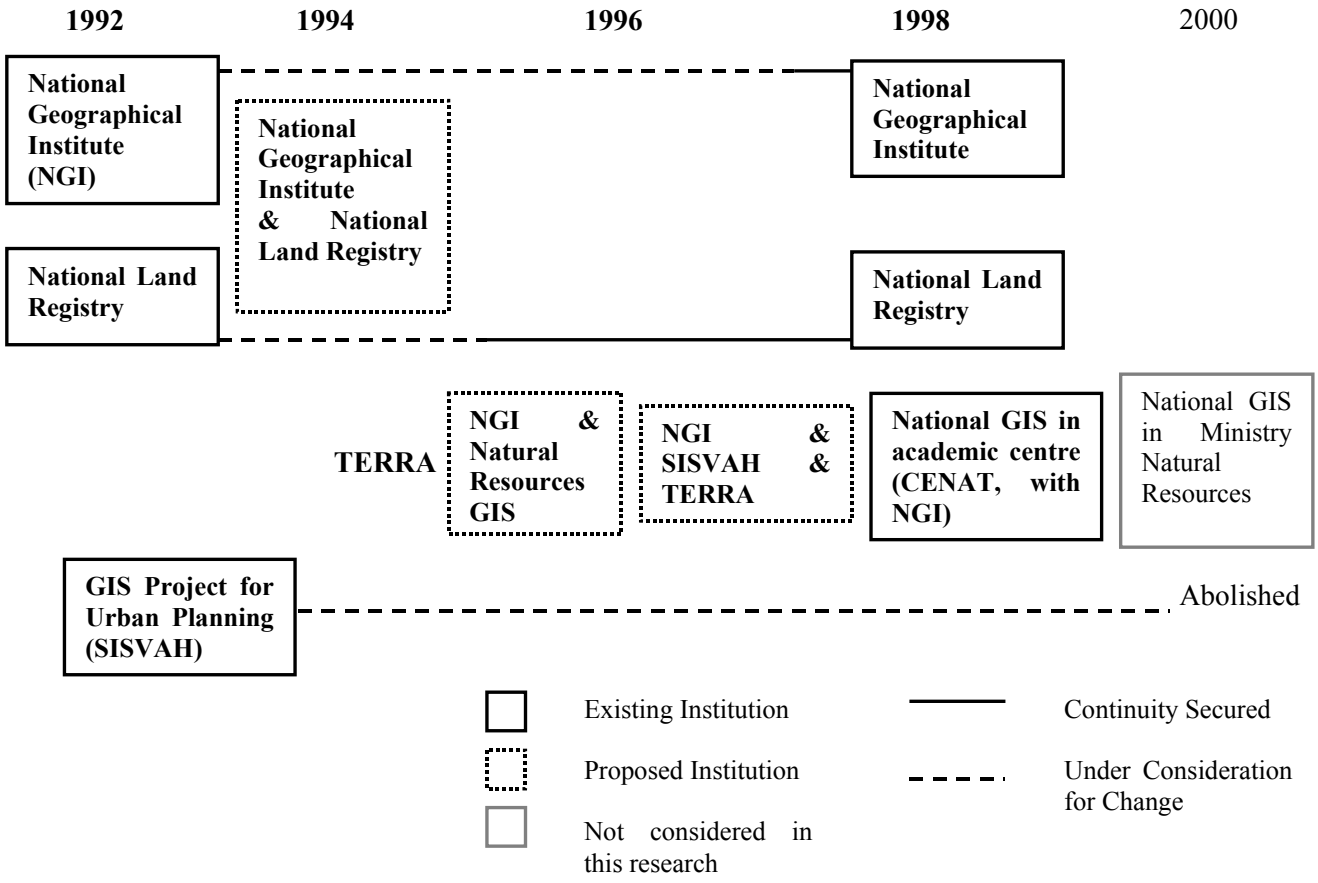


Figure 7.2 Location of a National GIS and the National Geographical Institute (1992-1998)

Just as in the other case study chapters, the first sub-section of each period will describe the GIS projects as well as their policy and financial background. The second section describes the technical and data limitations that each project had to overcome in order to reach its aims and objectives. The last sub-section will discuss the expectation and applications of the GIS projects, relating this to the contextual factors. All of this moves us closer to understanding the choices made during GIS implementation processes.

[12] It was renamed 'Ministry of Environment and Energy' in 1995.

7.3 National GIS for Decentralisation and Information Services 1990-1994

7.3.1 Government support for GIS: Projects and Policies

We can now consider the specific government support for implementing a National GIS during the first period. As we described in Chapter 3, the Calderon government (1990-1994), had a specific definition of 'ordenamiento territorial'. The government stimulated task specialisation in the different sectors of rural and environmental planning, and limited the term 'ordenamiento territorial' (and intersectoral coordination) to the urban areas.

This was already reflected in the governments' decision to close the Regional Offices of the Ministry of Planning and limit its tasks to macro-economic planning, towards state budget deficit reduction through fiscal measures (Rivera, 1997; Sojo, 1994). For urban areas, intersectoral planning was seen as a task to be executed through the municipalities. The Calderon administration therefore initiated a study on the tasks and 'services' (like police, water, education and garbage collection) that municipalities could take over from the central state[13] (Rivera, 1995). 'Ordenamiento territorial' was perceived by the Calderon government to be 'a functioning land registry'. The government made a large investment in the National Land Registry. This was to remove the bureaucratic limitations hampering efficient functioning of the land market. Other sectors, such as the environmental sector, were not given any role in urban planning.

The two most important GIS investments were in line with these policies (Table 7.2). First, the National Registry received generous support from the Dutch government, with a US$ 6,500,000 donation[14] to be invested in the technical capabilities of the National Land Registry and the actual registration of the large parts of the Central Valley (Alers, 1993). The investment in GIS soft- and hardware alone were estimated at 1.3 million US$ (Consultora Quatro, 1994). Through the investments, municipalities could receive assistance for the elaboration of their land registries. It was assumed that this would lead to the improvement of land tax recollection, which was seen as the foundation of 'ordenamiento territorial'. It was expected that through the GIS project, land value in the Central Valley could be reassessed, likely increasing property tax-income for the state. With this extra income, the Registry project could continue updating the rest of the country.

[13] The government also made a law proposal for the deregulation and decentralisation of services, but the law was not put on the agenda of the Assembly, reflecting the expected resistance within the National Assembly and the state system. The law proposal was not a priority for the government. It was, however, part of the World Bank Structural Adjustment Program conditionality (Rivera, 1997).

[14] The total project (with counterpart funds) amounted to over US$ 10,000,000 (MIDEPLAN digital project archive, 1996).

The Calderon government also hoped that the GIS project in the National Land Registry could become a multipurpose land registry. This Registry would not only have information of the location and registration of property, but also information on land and property value, coupled with land use and capability (COTI, 1993). GIS was supposed to help with "ordenamiento territorial", which, in the eyes of the proponents of a multipurpose land registry, was "...a system with information about land and its activities...that permits knowing and controlling what exists, what happens, who is acting with which authority, in every corner of the country" (COTI, 1993:2). The large investments made in aerial photography and equipment, supported the widespread notion that ideas existed to transfer the National Geographical Institute (officially responsible for these tasks), to the National Land Registry. This was confirmed in 1994, when the Calderon government proposed a study on the legal and institutional feasibility of transferring the NGI to the National Land Registry in order to create a National GIS for the country (MIRENEM et al., 1995a).

Table 7.2 GIS projects and products (1990-1994)

Year	Project name	Main agents in project	Expected results	Status
1992	*Multipurpose Land Registry Project*	National Land Registry	GIS training Digital land registry Aerial photography	Executed
1992	GIS for Urban Planning (SISVAH)	SISVAH, NGI	Topographic maps 1:10,000 Maps of 'services' Urban plans	Executed

The second large GIS project started in the infrastructure sector, with Canadian support. Investments in equipment were approximately 1 million US$ (Consultora Quatro, 1994). The GIS linked information on roads, water, electricity and natural hazards (Salgado, 1996). This project would assist the municipalities with the elaboration of regulation plans and coordination of these services at a local level, while it also would help the Ministry of Housing and Urban Planning with the regulation of building projects. This was in line with the philosophy of the Calderon government regarding a sectoral division of tasks, in which regional/rural planning investments in GIS were made through the sectoral institutes (Chapters 5 & 6). After the project contract expired, those involved proposed that the infrastructure, personnel and project skeleton become an information service institute that would sell its information. This was as solution to the problem of there being no financial resources for its continuation. The idea of making the GIS for Housing and Urban Planning (SISVAH), a 'service institute', did fit very well with Calderon's vision of decentralising responsibilities towards the municipalities. These in turn, could hire any technical expertise

required for their tasks. In practice, this would mean a privatisation of the assistance that autonomous institutions normally would give to municipalities free of charge[15].

Now that we have seen how the Calderon government promoted a specific version of GIS use for 'ordenamiento territorial', we turn to the actual implementation of GIS. The section below will first illustrate the importance of data and expertise as an enabling and constraining resources for GIS implementation. This section will be followed by the description of the actual choices and outcomes of the projects. These have been a result of government support and technical resources, in combination with the context of actual institutional change.

7.3.2 Expertise and data aspects of GIS implementation (1990-1994)

It was thought that GIS would make the whole registration process more efficient. To initiate the GIS was not an easy task, and required overcoming an enormous backlog given that hardly any part of the country had been entered into the system. It also implied the correction of all earlier errors. The project therefore focussed its activities on making a new property inventory of the Central Valley. The GIS implementation in the National Land Registry involved training many people in GIS and photogrammetry across various departments.

> *The information for the cadastral maps in Costa Rica has only been collected since 1981. The maps were made by private topographers, but only contained land transfers in the case of divisions of a larger holding. There was no correlation between the registration of property in the Property Registry, and the National Land Registry nor was there any link between these and a third registry, the Land Tax Registry. This created many problems. Only part of the land was mapped and registered and many claims overlapped. On top of this, it was very difficult and time consuming to synchronise the different registry systems. Although the private topographers' topographic plans seemed very exact, and complied with precision criteria, there was no guarantee of their quality, given the aforementioned problems and the absence of field control by the National Land Registry.*

Because of the existence of separate registries for property (in the Property Registry) and actual maps (in the National Land Registry), the organisation of data was problematic. If a property was sold in one piece, there was no obligation to convey this to the National Land Registry. According to the Dutch project team, solving these organisational problems was far more important for speeding up the process of completing the registry of land, than the technicalities of the GIS. The proposed solutions included mandatory land registration of

[15] The idea did not only exist in the infrastructure sector. The Ministry of Agriculture also suggested earlier that the information system could sell their rural zoning services to municipalities (GOCR, 1994; MIRENEM et al., 1995a), and the National Land Registry was in practice partly working as a consultancy bureau for the Ministry of Natural Resources' projects delineating parks (Interview GIS operator Conservation Area of Guanecaste, 1997) while they also charged for helping municipalities to set up their municipal land registry (Chaverri, 1997).

the transfer of ownership of entire properties. Topographers would also be required to include neighbouring cadastral plans during registration. The Dutch team proposed to lower the precision requirements of cadastral maps, but at the same time, demanded demarcation in the field of the measurements made. The Dutch claimed that while GIS could help once all maps would be introduced into the system to check overlapping claims, GIS in itself would not speed up the process, and sometimes even could slow it down (Alers, 1993).

The National Land Registry, however, put much emphasis on the technological issues and successfully demanded extensive investments in computers and software (Alers, 1994). GIS technology was not only useful for the registration process, but also meant power and prestige. In the National Registry, people thought, for example, that the GIS would have another explicit task. The director of the GIS department mentioned that their second most important aim was "updating of topographic maps". This statement indicated that within the National Land Registry, the idea of taking over the tasks of the National Geographical Institute, or absorbing it, was very much alive. " Not only do we have much more continuous information for updating these maps, but we also have better equipment and more trained personnel to do the job... They should become a department of the National Land Registry or maybe something parallel to it…"[16]. In this way, the technological advance was used as a legitimation of extending tasks and institutional domains. How these contradictory expectations of the National Land Registry and the Dutch project team were translated into actual GIS implementation will be described below. First, we shortly consider the parallel developments in the second large GIS project: the GIS for Urban Planning (SISVAH).

The GIS for Urban Planning (SISVAH) was conceived to assist the Ministry of Housing in guiding new building projects, and coordinating planning in urban areas. As part of this goal, it was to collect nation-wide information on infrastructure, in order to assists municipalities with the elaboration of municipal regulation plans. The project started with large investments in computers, software and training. A group of 6 GIS specialists was trained, by Canadian specialists. It was dependent on other state institutions for the data. The SISVAH project therefore trained various Ministries and Autonomous Institutes in exchange for information (mostly in paper formats).

As part of the project, the National Geographical Institute (NGI) signed an agreement with SISVAH to digitise its newly elaborated 1:10,000 topographic maps. For the NGI, this was of strategic importance given the negotiations on its transfer to the National Land Registry. The agreement, however, also had other implications. Since the project ended after 2 years SISVAH had to look for other funds. The idea of selling information was formulated as a creative solution to the government's budget constraints and inability to further support

[16] Interview (A7; 1-08-1997)

SISVAH. The SISVAH-GIS was permitted to sell the digital topographic maps, giving the National Geographical Institute part of the income. It was also to sell information and information services to municipalities for their elaboration of their regulation plans. With this new idea of 'selling information', the GIS community's perception of this National GIS changed completely. It meant drastic changes for existing norms and practices of data production and information exchange. It also had far-reaching implications for the actual implementation (and continuity) of this GIS.

7.3.3 Actual GIS implementation (1990-1994)

Returning to the National Land Registry GIS, given the enormous data problems, it is hardly surprising that implementation did not go as expected. The Dutch team director thought that often too much information was collected and problems existed with updating of collected materials. With less emphasis on technical issues the Registry could speed up enormously (Alers, 1994). At the pace of registration evaluated during the project, it was estimated that between 110 and 150 years were needed to complete the entire territory (Alers, 1993). The Dutch project team tried to lower the expectations, set priorities and limit the National Land Registry to its primarily tasks of a cadastral registry. As we will see later, it hardly achieved any success. But let us first look at the Registry part of the GIS.

The original idea was that, with additional income generated through the tax system, the project would be able to finish the land registry of the rest of the country. This did not work. Firstly the National Land Registry didn't receive more income, because it was absorbed by the central government. But secondly, technical problems on valuation, inflation correction and the low tax in itself were creating obstacles. In Costa Rica, taxes on real estate amounted to 20% of government revenue in 1960, but by 1989, it had dropped to a mere 1% (Celis & Strasma, 1992). Moreover, there was a fight about the reforms in tax collection, which made it unclear as to who would reap the benefits of an up and functioning land registry: the municipalities or the Central Government. Because of the enormous costs and administrative problems, some even questioned the viability of a national tax system altogether (Skinner, 1991). Finally, the National Land Registry did not declare the projects' registered areas 'officially registered', which otherwise would have enabled the start of official land taxation. But the Dutch experts suggested that the National Land Registry also seemed to be reluctant to declare an area as 'totally registered', because the risk of the National Land Registry wrongly giving a land title (to land already claimed by others), could lead to possible legal claims put forth by land owners (Alers, 1993).

The data problems combined with the lack of money for the continuation of the measurement and digitalisation of properties led to a stagnation of the GIS-Registry. At a conference on land registry in Heredia, in 1997, an international expert mentioned that the

updated areas were never legalised and actualisation of recent changes were not introduced systematically, which caused serious loss of the investments made during the Dutch cooperation project.[17]

The lack of progress in the Registry can also be partly explained by its emphasis on technological issues. But as we explained above, these 'technological issues', had often a more political background. With the investments in modern GIS and photo interpretation equipment, the Registry became the institute with the biggest capacity for data storage and the most sophisticated Geographical Information System (Consultora Quatro, 1994). At the same time however, the National Geographical Institute was responsible for aerial photography, 'official' map making and the geodetical network. The project created duplication of tasks between the two institutes, with considerable overlap in expertise of aerial photography and GIS-applications (Dekker, 1992). During the project, there was little contact between the project and the National Geographical Institute regarding, for example, the elaboration of aerial photography. This demonstrated some disagreement and rivalry over investments in times of state budget reductions. The suggestions of a merger between the two institutions made the 'technical issue' even more political.

Given the Calderon government's proposals (MIRENEM, et al.1995a), we can assume that some agents in the National Land Registry and the National Geographical Institute (NGI) were in favour of merging the capabilities. But there was also indication of reluctance within the NGI. After the declaration of the National Land Registry project in 1991, the NGI immediately put out a (ministerial) decree, claiming responsibility for topographic mapping. The decree also included its role as being responsible for 'the development of GIS' (GOCR, 1991c). In this light, the efforts to create a digital 1:10,000 map for the Central Valley (through the SISVAH project) could be interpreted as much more strategic than as just another 'technical project' for the institute. Even if the NGI was not completely opposed to a merger, it at least wanted to go into any negotiations on this subject from a better bargaining position. This would guarantee its input in the choice of an optimal institutional embedding for the future.

One of the other locations of the NGI (as we shall see when reviewing the period 1994-1998) was the foundation that ran the GIS for Urban Planning (SISVAH). Within the SISVAH, GIS implementation also stagnated however. First, 4 persons trained in GIS left for the commercial sector, or to study abroad. Secondly, the inexperience of the personnel that remained behind, led to the digitisation of the topographic maps of the NGI without its geographical co-ordinates. While these maps maybe useful for local urban planning (and a single map sheet), it was impossible to link more maps together or combine it with geo-

[17] G71 (29-10-97)

referenced material. But finally, and perhaps more seriously, the idea that the SISVAH would function as a commercial organisation was received with suspicion. The GIS community was not impressed that SISVAH would sell information that had previously been provided free of charge (Chapter 3). With the failure (or at least delay) in the production of a digital topographic map of the Central Valley, the NGI did not emerge stronger in the negotiations for its transfer to different locations.

The actual implementation of the GIS projects demonstrated how different planning led to specific choices for using GIS as vehicles to induce institutional change. The National Land Registry tried to absorb the National Geographical Institute in order to become a powerful player in municipal regulation, while the GIS for Urban Planning and Housing tried to stimulate deregulation and decentralisation through organising information expertise as an 'information service'. Both ideas suited the Calderon government's intention to deregulate planning, and stimulate 'ordenamiento territorial' steered by the market. Both projects did not meet the expectations. The main reasons were technical problems, but also of data exchange, and other parties (the National Geographical Institute, or the GIS community) refusal to cooperate. Without having considered the wider context and discussions of planning it would have been impossible to understand the complex relations between institutional change and GIS implementation.

7.4 A National GIS for 'Ordenamiento Territorial' (1994-1998)

7.4.1 Government support for GIS: Projects and Policies

In this section, we will describe the implementation of a National GIS for 'ordenamiento territorial', as envisioned by the Figueres government. After 1994, the government's intervention philosophy shifted towards planning where the environment was seen as an intersectoral issue. This line of thought was pushed by centralist technocrats and environmentalists from the social democrat PLN-party, favouring state involvement in "ordenamiento territorial". The government program, proposed to stimulate 'an intelligent division of responsibilities that combines forms of centralisation and decentralisation' (MIDEPLAN, 1995:131). Various government documents mention that centralisation of information was a key to state reform, and a new form of planning. It would "enhance the normative, guiding, coordinating and strategic character of the State" (MIRENEM et al., 1995a:48; Lücke, 1994), and was important for "...the establishment of criteria for 'ordenamiento territorial'..."(ibid.:42). It was hoped that centralisation would accelerate strategic decisions and give more power to the executive by bundling information production and land use regulation into one body.

The Figueres government first created five intersectoral 'areas' where ministries' activities would be coordinated. The 'Council for the Area of Sustainable Development' (CADES) defined government policies and guided international donor money for all spatial planning issues. It had its secretariat in the Ministry of Planning. The council was to be supported by a central information system, connecting all Ministries and state institutes. The computer network and institutional arrangement, called "the System for Sustainable Development" (SINADES), was financed by the IADB. Nearly 3.2 million US$ was invested (Lücke, 1994; IADB, 1998). The SINADES project was formulated as 'an independent project to help with state reform' (Lücke, 1994). The 'project-nature' and independent financing were to prevent interference by the bureaucracy and to avoid changes in top-officials after elections (ibid.).

The Council for Sustainable Development[18] consulted several technical committees for advice. They proposed legal and institutional change for the integration of the different activities. A committee (referred to as TERRA) was created for reforming intersectoral land use planning (MIDEPLAN, 1995). TERRA's tasks were defined as (GOCR, 1995a):

- the elaboration of a Spatial Planning Law (ordenamiento territorial)
- creation of a binding National Plan for 'Ordenamiento Territorial'
- the establishment of a National GIS to support the planning process
- the coordination of all spatial planning projects in the country

TERRA's planning vision was centralist, and its culture of functioning was one of evading state bureaucratic rules. It proposed 'creative solutions' for administrative obstacles (Box 7.2). The committee consisted of representatives from the Ministries and State Institutions, together with people named by presidential decree. Originally, the GIS was budgeted for 78,000 US$, but this was raised to 360.000 US$, giving an indication for the government's ambitions for the Committee for Ordenamiento Territorial (Lücke, 1994; Cotera, quoted in Chavez, 1995). In official documents, TERRA was presented as the "National Geographical Institute's National Commission" (MIRENEM et al., 1995b: annex D13).

[18] The Council also received advice from the committee CONADES. On this committee were representatives from private, academic and NGO sectors, as well as officials. The decree creating CONADES explicitly stated that it was to stimulate national consensus. The decree, however, did not stipulate the committee's specific powers. It only suggested that CONADES 'stimulate', 'recommend' and 'coordinate'. The government was not completely comfortable with having civil society groups so close to government projects. When TERRA, the committee for 'ordenamiento territorial', had received its initial project financing (US$ 350.000), and with prospects for another US$3.000.000 forthcoming, some comments were made at the meetings, cautioning that the CONADES could start to demand how TERRA spend its funds. "...[T]hat is the danger of democracy...", one of the leaders of TERRA remarked. And referring to 'those populist NGOs': " Espinach [the director of the Area for Sustainable Development] always warned me that one has to keep those people busy with tasks, otherwise they could start trying to manage us' (TERRA meeting notes, 22-04-1996).

Table 7.3 GIS projects and products (1994-1998)

Year	Project name	Main agents in project	Expected results	Status
1995	*National System for Sustainable Development (SINADES)*	MIDEPLAN TERRA	National GIS	Partly Executed
1995	'*Project for Conservation and Management of Natural Resources in Costa Rica*	MINAE NGI, Land Registry	Topographic Maps 1:50,000 Forest Cover Map, National GIS	Not Executed
1996	Agreement NGI-MINAE	NGI, TERRA, MINAE	National GIS for Natural Resources	Not executed
1996	Agreement RECOPE	TERRA	Topographic and Theme maps 1:25,000	Partly Executed

Besides the SINADES project, the government formulated a World Bank loan proposal, called the '*Project for Conservation and Management of Natural Resources in Costa Rica*' (Table 7.3) (MIRENEM et al., 1995a). The World Bank project not only aimed enhancing the Ministry of Environment and Energy's responsibilities in regional planning, but also it was to make the Ministry responsible for official national information production. Over 15 % (over US$ 3,600,000) of the original amount proposed was earmarked for the renewal of the topographic base maps, and the acquisition of computers. The project annex referred to the mapping efforts as "the Institutional Strengthening of the National Geographical Institute (NGI)", and described options for its relocation (Green, 1995). The World Bank project document was not explicit about the location of the NGI. The first option proposed, was the creation of a new institute for natural resource information, topography and land registry, linked to the Ministry of Natural Resources. This could include the transfer of personnel and competence of sectoral GIS facilities (e.g.., soil mapping) (MIRENEM et al., 1995a, 1995b). The second option was to split the NGI in a Topographic Department of the National Land Registry, while its Geographical Department (with studies on natural resources) would go to the Ministry of Natural Resources.

The intentions of the World Bank project and the SINADES project obviously seemed to overlap, but contradicted each other on the aims and location of a National GIS. In a 1995 draft version of the proposal, one of the authors had hand written in the margin next to a paragraph on TERRA and the NGI location: "unclear…to be worked out in more detail" (MIRENEM, et al., 1995a). What a comparison of the SINADES and World Bank project underlined is that the government team did not reach consensus on the NGI-issue. Some wanted an intersectoral National GIS, close to the president, while others wanted to create a National GIS in the Ministry of Environment and Energy.

Box 7.2 TERRA's vision on 'creative functioning'

The culture of the TERRA meetings was informal. Only between the jokes was there an exchange of important information. There were no meeting notes, no attendance lists, and no documentation of the decisions made during the meetings. The many meetings I observed did not seem to be efficient. They were often confusing and more like 'an old boys club'. During the meetings, many comments were made, hinting at the superior nature and enlightened leadership among TERRA core members. "There are two kinds of participant", remarks someone from the 'outer circle'. "The ones who get paid and us...We are only here to supply information…". Another member mentioned;" ...just compare the people on the fax list who are supposed to be invited and present...only three or four people are present...so who is making the decisions…"?. The director of TERRA explained that his committee consisted of "...a group of friends from a Environmental Committee for the PLN. When this PLN administration came to government, we started TERRA. We invited also one representative from every ministry, if they were not yet part of our discussion group. Some of them didn't show up at all (like the representative from the Ministry of Environment and Energy), but one of their consultants always came, so that is OK…" TERRA tried to act as a creative visionary group, making 'responsible decisions' on the country's behalf. In official documents, reference was made to futurologists such as Kahn, McLuhan and Chopra, who inspired TERRA's vision of the' new era of high technology' (Cotera et al., 1998). This culture of centralist, technocratic elitism resulted in a tension between TERRA and the state bureaucracy. The TERRA members evaded the state bureaucracy as much as possible, because of the delays, stagnation and indecision. The "technocratic" frustration with the bureaucracy was expressed most clearly by one TERRA member who was the country's former Vice President:" I am worried... that the decision making structure in the country is totally ... atrophied, due to erroneous ways of managing administrative and legal aspects, and control. ... [T]echnically speaking, I would now have to be in jail for making all the decisions I did, while establishing the ICE [National Electricity and Telephone Company]...[N]ow these decisions would have been illegal...because the complexity of laws is so large. This is causing a 'pendejera ejecutivo' [executive consisting of weak and corrupted people], because people know that if they make a decision they will be held accountable [and even wrongly accused].... We have to rise to the occasion of our capacity to make decisions. This brings with it responsibility, and accountability to the country, and not to the National Financial Control Office...[I]t is really about the presentation of results..." (Dengo, 1992: no page numbers).

Table 7.4 Discourse Analysis of TERRA's Self-Definition

(source: Own meeting notes 'TERRA' and Cotera et al. (1998:43)

Us	***Them***
Technocrats	Politicised people
	(Dis-)functionaries
	Sociologists
Open	Secretive/moralist
Nature	Private/economic interests
Friends of President	Bureaucracy
Participatory	Populist
Visionary	Backward
High technology	Industry/agriculture
Fast	Slow
Meditation	'Old' religions
Observed	Observing

The difference in opinion on the location of a GIS became more complicated in 1995, when the Figueres team was split. The schism surrounded a secret deal that Figueres had made with the opposition party to follow a more neo-liberal course. The new policy line led to the abolishment of the Council for Sustainable Development. It also meant that many technocrat proponents of 'planned intervention' left the government team[19] (Barahona et al., 1999). The SINADES project continued, without the Council, as a project of the Ministry of Planning.

While at first everybody expected the World Bank project to continue, after the government split in 1995, this 'priority project' was withdrawn from the agenda (Camino et al., 2000). The government invented 'creative solutions' to guarantee information production, in the absence of the World Bank project. It used the budget from the National Oil Refinery. The 'creative solutions' were two-fold. There was an agreement between the National Geographical Institute and the Ministry of Environment and Energy to collaborate on projects promoting 'ordenamiento territorial'[20]. The agreement would also promote the transfer of the National Geographical Institute 'to a new location'[21] (MOPT/MINAE, 1996). This agreement was accompanied by a National Oil Refinery investment in topographic mapping, in order to create databases 'for decision making for the energy sector'. The National Refinery (that fell under the responsibility of the Minister of Environment and Energy) invested 3 million US$ in this project that TERRA was assigned to execute (MINAE/RECOPE, 1996).

Below we will describe how these projects, 'the creative support', as well as the uncertainty and indecision within the Figueres government, all affected GIS implementation. First, we will look at key aspects for this project: the data and expertises. Secondly, we will look at the actual implementation as a complex negotiation between sectors and institutions.

7.4.2 Expertise and data aspects of GIS implementation (1994-1998)

> *"Electronic technology permits one to decentralise the productive activity and services, and centralise information". According to the director of TERRA, it was the information that had to flow. "If we breed cattle in the lowlands we shouldn't have to bring them to the Central Valley to produce meat, which we consecutively transport back frozen for*

[19] see:*La Nación, 10-06-1995; La Nación, 17-12-1995*

[20] The IGN was supposed to help with the provision of information for sustainable development, while the MINAE would 'help' the IGN with the modernization of the institute, acquisition of new equipment and data gathering. The IGN would have to develop a digital national geographical database, correct, evaluate the data and make it available for the public (MOPT/MINAE, 1996).

[21] The sub-director of the IGN doubts if the agreement between the Ministry of Transport and the MINAE will ever function.

export..."[22]*. "Only information and decision making should […, therefore,] be strategically centralised" (TERRA, 1995). Maps "... will stop being static and, as in many cases now. They will stop being just decorations in offices. GIS will play a fundamental role in analytical work, and for decision making. It is moreover a new tool to administer and govern the country effectively…" (Cotera et al, 1998:35).*

TERRA divided its information goals into four areas, seen as essential for 'ordenamiento territorial' (TERRA, 1995; Dengo, 1998d). There were:
1) Zoning
2) Political and socio-economic analysis
3) Natural resources inventory
4) Urban and regional planning

TERRA's ambitions were high. It promised to resolve 'information feuds' and create networks that would make the country an international example of sustainable development (Cotera, in Fallas, 1995). To reach these goals, it needed cooperation from all sectors. TERRA would, following its founding decree, work with personnel from other state institutions, which were to be temporarily transferred to TERRA. Existing information would be put in a database and missing information (such as soil maps, and updated land use maps) was to be generated through consultancies. TERRA would also help find international financing for new maps, and set priorities for their development.

The future looked bright for TERRA. The SINADES project provided TERRA with computers and software. The Ministry of Environment and Energy guaranteed the investment in topographic maps, and later even funds were reserved for the elaboration of thematic maps and personnel. TERRA itself had to deal with limited financial support from the state due to structural adjustment programs. These programs forbade hiring public sector employees. Behind the scenes, the core group in TERRA found political support, for indirect investment in the committee, avoiding these World Bank restrictions and, "without having to go through the tedious process of financial checks..."[23]. TERRA was to be responsible for a National GIS project drawing upon finances earmarked for computers (investments) but without direct budget for personnel and other recurrent costs. Indirect investments, however, could support the committee, while evading administrative regulations. We will now have a closer look how such creative solutions were linked to some more technical aspects of data. First we will describe how the elaboration of the topographic map was organised. Secondly we will turn to the thematic maps from the 'wish list' of TERRA.

[22]TERRA meeting notes, 4-03-1996

[23]TERRA member (G6, 29-10-97)

Topographical maps

The National Land Registry [and not the National Geographical Institute (NGI)] advised TERRA in the project for topographic mapping. The Land Registry was partly being paid for its services. As member of TERRA, the director of the Land Registry advised on the elaboration of topographic maps, while an international German consultant was hired to supervise the aerial photography.

> *In fall 1996, TERRA spent its meetings making terms of reference with the priority for the aerial photography. "...We came to the conclusion that we have to make the effort to pay for the photography of the whole country in the first year and assure that a local company will do the restitution, to avoid hiring foreign experts in the process" (Cotera, 1997). After a complicated procedure, finally a Canadian-Mexican bid was selected because "they were the cheapest and they will hire Costa Rican specialists for digitisation"*[24].

The new maps were elaborated through GPS measurements of a new geodetical network for the restitution of the aerial photography. This was more problematic than TERRA had expected[25]. With only the National Land Registry as advisor on technical issues, the German International expert complained that height measurement was not adequately understood by TERRA[26].

At that moment, the NGI was already working on a digital map of Costa Rica. They had already completed the 1:200,000 map (together with the University Centre 'CIEDES', the Tropical Agronomy Research and Higher Education Centre (CATIE) and the Agricultural Ministry's FAO project). At that moment they were doing the quality check for the 1:50,000 map, which was made with the National Electricity Institute. Finally, a revised version of the 1:10,000 map was made with the GIS for Housing and Urban Planning[27]. By the time TERRA finally produced the aerial photography and first map sheets, the NGI maps were

[24]TERRA meeting notes, 9-06-1997

[25] GPS technology works through measurement of the distance between a satellite and the earth surface (or the GPS station). For the calculation of the height in many 'data-poor' countries, the difference of the distance between an 'ideal earth' (assuming this would be sea level) and the measured distance by GPS is taken as the height above sea. Because the earth is not a perfect sphere for precision measurements one has to calculate a 'model of the earth-geode', to correct for the unevenness of the real earth surface (for a discussion on Costa Rica see: Diaz, 1997c). In conventional measurements, this correction was not necessary because height was calculated relatively to one standard location. With GPS, one can measure x,y,z at a certain position without the need to link the measurements to an original network of verified points. This system is useful for many civilian building or administration applications, but also of strategic importance for new military practices of remote control 'smart' precision bombs.

[26]The German expert calculated that following the new model, the coastline would sometimes be 1 meter bellow sea level. The expert suggested that the lack of attention to the exactness of the altitude could be explained by the institutional background of TERRA's advisors. For land registry purposes normally only the horizontal coordinates are important, while the altitude is less important.

[27] Subsequently, the IGN discovered that the US Mapping Service had also elaborated updated digital maps, even tripling the enormous investments in digitisation of these maps. The US still needed Costa Rican input for the names and field checks (M10, 21-10-1997).

almost completed. This demonstrated that the government actually supported different institutions, duplicating data projects. This suggests that there was a power struggle over institutional reform.

The Thematic Maps

Besides the data of the topographic base maps, TERRA made a 4-page list of information themes that they 'wanted to have' in order to make their National Plan for Ordenamiento Territorial. This was divided in themes of Biophysical and Natural Resources Information, Ecosystems, Services, Social and Demographic Aspects, Economic Activities and Legal, Institutional and Administrative divisions. Throughout the months of meetings, the blackboard in the TERRA meeting room showed 'the most important' layers in descending order of importance (freely translated):

Table 7.5 **Information Layers For 'Ordenamiento Territorial'**

1. Conservation areas
2. Land Use
3. Rivers
4. Industries
5. Urban and recreation areas
6. Vulnerable areas/natural hazards
7. Infrastructure (roads, electricity, oil pipelines, etc.)
8. Energy projects
9. Mining & Natural Resources

The data 'wishes' reflected the importance of environmental issues as central pillar in Figueres 'green business' logic (Table 7.5). It also illustrated that 'ordenamiento territorial' was perceived as an intersectoral activity. The last two information layers were indicating the importance of the National Oil Refinery for TERRA's activities. This institute (that had financed most of TERRA's activities) clearly had to be accommodated.

> *Remarks during the meeting would indicate that this was more 'lip-service' than strategy:"...We should also elaborate something to keep them happy, even if it is a useless map, something with oil pipelines, or whatever...*[28]*. "The Refinery can ask for specific products, as part of the agreement. They are officially 'the client'...but we can still do 'our own thing'..."*[29]*.*

TERRA was dependent on others for its information. In 1996, TERRA first wrote letters to all GIS institutions in Costa Rica, requesting the transfer of all digital information in their possession. The letter was signed by the President of the Republic. We can identify this as perhaps the most overt moment of trying to attribute power and legitimacy to TERRA as a 'pet project' of the Figueres executive. The reactions, however, ranged from outright

[28] TERRA meeting notes, 3-04-96

[29] TERRA meeting notes, 22-09-97

laughter, through indifference to anger. The institutions realised that TERRA had problems with their institutionalisation, and felt that TERRA was avoiding 'official' and 'normal' practices of data exchange. This also created the feeling that TERRA had something to hide. After a few months, TERRA only had received: some data layers from the National Emergency Centre; a soil map without database from the Ministry of Agriculture; paper mapsl from the Mining Directorate; an incompatible digital terrain model from the Tropical Agronomy Research and Higher Education Center (CATIE); a 1992 land use map from National Meteorological Institute; a map on life zones from the Tropical Science Center. Most GIS laboratories did not react at all.

> *"The National Geographical Institute received three letters with a request to respond to TERRA in their name", stated the sub-director in a TERRA-meeting early 1997. "We already warned you before that you can not ask to be sent just any information. Who is going to check the quality of all this information? This way, you run the risk of gathering garbage"*[30]. *In the Ministry of Agriculture, an official explicitly mentioned: "...we gave them just some information, but of course not everything..."*[31]. *Others commented that without more specifications on topics, scales and format they could not deliver any information at all. "It is 'simplistic to think they can just import all information into a GIS with different software', because if you try to change ARCINFO to INTERGRAPH you can loose attributes. There is always a difference between the theory and the practice. It is not always as the software folders promise, you have to figure it out by yourself..."*[32].

Failure to discuss and define the term 'ordenamiento territorial' caused confusion. As several people mentioned in the meetings, 'without a picture of the goal TERRA was working towards, there could be no discussion of the information needed'. After TERRA failed to arrive at some kind of data exchange, it tried to make terms of reference for a consultancy contract for the elaboration of thematic maps. Around the same time, the Minister of Agriculture had its soil-mapping project approved, and the Ministry of Environment and Energy had hired its own consultancy for the forest cover maps, suggesting that most institutes had lost faith in the TERRA initiative.

While enormous investments in data production were enabling TERRA to convince others to cooperate, at the same time TERRA was constrained by their unconsolidated position and dependence on others to make the project a success. We have seen that TERRA was faced with difficulties such as a lack of expertise, data exchange, and duplication by other institutes of their project activities. With this in mind we can turn to the actual implementation of GIS as a process of negotiation for TERRA's institutional embedding.

[30] TERRA meeting notes, 12-03-97

[31] IICA meeting notes, 12-08-97

[32] TERRA meeting notes, 12-03-97

7.4.3 Actual GIS implementation (1994-1998)

We are now at a point were we can analyse how government support, data and expertise were used to implement GIS, as part of a complex process of institutional change. Support, funding and plans were one thing, but as we already saw in the discussion of data and expertise, actually implementing a National GIS was something else. Mid 1995, after the withdrawal of the environmental sector World Bank project, and the political shifts inside the government team, the situation became even more complicated for TERRA. Even though it was established by decree and had been donated computers for its GIS, its institutionalisation became an ironic stumbling block. The search for a location for GIS [a technology of location] was the main problem. Table 7.6 illustrates the many proposals for a GIS location made to the government. The proposals indicated that TERRA's plans were part of a wider field of negotiations, held 'in the corridors', and behind closed doors[33].

In the first year of the Figueres government, several proposals (Table 7.6) suggested the creation of an intersectoral steering body. This institute would be assisted by a National GIS, uniting Land Registry, NGI and possibly other sectoral information bodies[34]. TERRA had defined itself as being the new planning body. At the same time, it aimed to become the 'owner of the new GIS[35]. The proposals suggested that the new planning cum GIS should be located in a Presidential Office or function as an autonomous institute (possibly in a public university). There was clearly a tension within the government given that the Ministry of Natural Resources also claimed to make 'the National GIS through its World Bank project'.

TERRA's actions suggested that it was interested in inducing change 'on the ground' before changing the law. It was a plausible strategy, since divisions within the Figueres government team (and in the National Assembly) would did not have guaranteed a majority for legalising institutional change for central planning. Already from the start, information was perceived as a strategic means for forcing a decision on the planning authority. Laying claim to the information capacity almost inevitably inferred institutionalisation of a planning body around it.

[33] This made it very difficult to establish what exactly happened, or to give a complete history of developments around TERRA. From my meeting observations, in combination with documents, interviews and research on the context, I have been able to reconstruct the important events. This enabled me to understand the shifts in preference for TERRA's GIS location, as well as its decision making strategies.

[34] The inclusion of the Land Registry was mentioned in a project proposal for the Dutch government of 1995(TERRA, 1995 and the final version of the World Bank proposal (MIRENEM, et al., 1995b). The fact that personnel from the sectoral offices would be 'loaned' to TERRA's GIS was a strong indication that these offices were to be absorbed in this new 'super-institute'.

[35] TERRA director (G2, 20-02-96)

Table 7.6 Official Proposals to the government for the locations[36] of the National GIS and 'Spatial Planning Office'.

Location Spatial Planning Coordination	**Location National GIS**	**Origin of the Proposal**	**Source and Year**
Min. Natural Resources	Min. Natural Resources	Academic	Lücke (1993)
Min. Planning	Min. Planning	Consultancy Report	Lücke (1994)
Presidential Office	Academic (CONICYT)	Law proposal	CEDARENA (1995)
Min Natural Resources	Land Registry (Min. Justice)	WB Loan proposal	MIRENEM, Et al. (1995a)
Min. Environment Energy	Academic (CONICYT)	Law proposal	CEDARENA (1996)
Autonomous Institute	Autonomous Institute	Academic	Pujol (1997b)
Min Environment Energy Or Autonomous Institute	Min Environment Energy or Autonomous Institute	Government Agreement	MIDEPLAN/ MINAE (1996)
Foundation	Foundation	Meeting notes	TERRA - Meeting 1996
Foundation	Academic	Government Agreement	MIDEPLAN/ ITCR (1997)
?	NGI & Land Registry (Ministry of Justice)	Consultancy Proposal	Jung (1997)[37]
Foundation	Academic (CENAT)	Presidential Decree	Dengo (1998b)
Autonomous Institute	Autonomous (NGI, Census, IFAM)	Law proposal	GOCR (2000)
Sectoral	Dir. Hydrocarbons (CENIGA)	Presidential Decree	MINAE (2001)

"We have to make a deep furrow, so we can only move forward. If we only make one of five meters wide, it will disappear with the wind". In the TERRA meetings, the director defined TERRA as a 'permanent committee' that had to continue regardless of the administration in power[38]. The coordinator of TERRA emphasised that a National GIS was central for TERRA because "...planning in Costa Rica doesn't exist... Through this GIS, we can orient our goals without falling into the trap of 'master plans', which have the plan as a goal in and of itself. For example, ECODES doesn't ask 'how do we do it? ...our approach is

[36] CONICYT (National Committee for Science and Technology); CENAT (National Centre for High Technology); IFAM (Institute for the Development of Municipalities); CENIGA (National Centre for Geo-environmental Information).

[37] During an interview he mentioned that he had recommended this option to the Costa Rican government, as part of an official evaluation of the National Land Registry. He could not give me his final evaluation report, because it was not distributed to 'outsiders', as stipulated by the executive of the National Land Registry.

[38] TERRA meeting notes, 4-03-96

different"[39]*. TERRA saw itself as planning body and a National GIS. A government official confirms:" TERRA was totally focused on centralisation of information…."*[40]*. Taken together, the quotes suggest that a GIS and information was seen as a strategic means to survive, because once the information was collected a new government could not 'just dissolve' the committee.*

When the Figueres administration changed its course, TERRA lost many allies within the government. Without the Council for Sustainable Development, it became a project of the Ministry of Planning. A new strategy was proposed to make TERRA and a National GIS part of the Ministry of Environment and Energy[41]. As we mentioned earlier, the Ministry of Environment and Energy organised the funding for the topographic mapping (through the Oil Refinery) and signed an agreement with the NGI. The arrangements were referred to as "a generous offer to the National Geographical Institute that would convince them to become part of the Ministry"[42]. The Ministry also wanted to absorb the task of intersectoral planning as part of its obligations for guaranteeing 'a healthy environment'[43]. For TERRA, the agreements were seen as an opportunity to start building 'their own GIS'. From the meetings, interviews and various and documents, however, it is not clear whether or not TERRA (as a project under responsibility of MIDEPLAN) really intended to move its headquarters to the Ministry of Environment and Energy. It was evident was, however, that as the 'committee responsible for the execution of the agreements', TERRA had the strategic resources that could be used to reach their goal[44] (of being an intersectoral planning body).

The new set up for TERRA activities was complex. TERRA was now officially working for two Ministries (Planning, and Environment and Energy). This led to ample negotiations over the final destiny of computers, data-investments and GIS. But the proposal to become part of the environmental sector (even as an autonomous institute) also generated reactions form the sectoral bureaucracy. It is not the intention to give a full account of TERRA's activities. I will only illustrate the main tensions that arose during TERRA's GIS implementation.

[39] TERRA member (G3 18-06-96)

[40] Government Official (M7, 10-20-97)

[41] TERRA meeting notes, 04-30-97

[42] Interview with advisor to the Vice-Minister of Environment and Energy (M18, 9-02-1996). The sub-director of the NGI emphasised, however, that for the NGI other options still were open. (M4, 20-12-95).

[43] This claim was made in the General Environmental Law and government documents (e.g., MIDEPLAN/MINAE, 1996).

[44] When the agreements were reached, TERRA was still waiting for the SINADES computers, and cooperation from other sector information offices was uncertain (see section 7.4.2).

Sectoral boycott

The discussions during TERRA meetings, in early 1996, indicated problems. The sectoral representatives in TERRA warned that the sectors would not agree with the placement of an intersectoral planning committee under one of the 'sector Ministries'. But the core group in TERRA was evading discussion on the institutionalisation. Every time it came up during the meetings, the director emphasised that this would be "a policy makers' decision", and that TERRA was "just a technical committee"[45].

> *In a report to the IADB, TERRA's director mentioned at least 5 meetings with high-ranking officials, that took place between March and June 1996, to discuss the installation of TERRA in the SISVAH buildings. In the end, he optimistically announced the transfer during the TERRA meeting. " ...the 14th of May we had a meeting ...with the goal to discuss alternatives for the future of the SISVAH, and the possibility that the TERRA could absorb it, through the National Geographical Institute, and transfer TERRA's head office to the building of the SISVAH" (Cotera, 1997:no page numbers). "TERRA will be part of the National Geographical Institute, and the National Geographical Institute will be transferred to the MINAE.... We will remain independent by moving in with the SISVAH. Maybe later we can find a building where everybody will go together"[46]. He faced a lot of protest from different ministerial representatives in the committee. Who would be the owner of the products after the project ends? The computers from the IADB were the responsibility of the Ministry of Planning, through the SINADES project. But the resulting 'end products' (the maps) would be the property of the National Oil Refinery, since this organisation financed them. It was not clear whether TERRA or SISVAH should keep these products, let alone distribute them[47]. A representative of the sector commented that:"...theoretical exercises about environmental impact on a very general level were not very rational [for SISVAH]", given the "limited resources, and the urgency to have our own information system for monitoring urban development. [W]e decided that there was no reason for the transfer of SISVAH to TERRA, - nor the National Geographical Institute, ...certainly not after the consideration was evaluated to create a national body... in which the National Geographical Institute and the Census Office would be united, - which by the way also didn't prosper"[48]. A respected urban planning professor openly accused the MINAE of "environmental imperialism", wanting to absorb also urban planning into its area of influence. He thought that it would be wiser to create the National Office for Ordenamiento Territorial through the fusion of the National Geographical Institute with the Directorate of Statistics and Census and the National Land Registry. The urban sector opted for an autonomous institute, combining the NGI, GIS and planning (Pujol, 1997b).*

By June 1996, most sectoral representatives stopped attending the TERRA meetings. They thought that institutionalising TERRA (and a National GIS) in the Ministry of Natural

[45]TERRA meeting notes, 23-09-96

[46]TERRA meeting notes, 22-04-96

[47]TERRA meeting notes, 22-04-96

[48]Government advisor of the housing sector (M14, 22-01-1999; M15, 1-03-1999)

Resources was unacceptable[49]. The former Vice-President, and key figure in TERRA, Dengo, later admitted that, "…the idea of moving the NGI to the Ministry of Environment and Energy was meant to reform the NGI and create an information institute of political importance… The idea, however, was conceptually wrong, because we excluded urban issues, infrastructure, etc. from intersectoral planning"[50]. To evade the discussion, TERRA proposed to keep its independence by creating a new foundation or independent institute. We can assume that the Ministry of Environment and Energy did not agree with this idea. The Ministry still decided to give the green light to the Refinery for releasing the funds in June 1996. Because the topographic mapping products would be owned by the Refinery, the Ministry was still in a powerful position for further negotiations.

The state bureaucracy and the executive

Protest from the sectoral institutes meant that TERRA was not in a position to work with their personnel as had originally been planned. The funds from the Refinery were also to be used also for this purpose. While elaborating the consultancy contracts, and the international tender for the topographic mapping, the Refinery started slowing down the process. The official reason was that the Refinery was administratively forbidden to hire personnel for TERRA. Also, the proposal for the international tender was sent back and forth for three months for administrative corrections (Cotera, 1997). In the meetings, TERRA members reacted with anger and frustration at the stagnation, but after strong lobbying by the former Vice-President, finally the tender was advertised on December 5th, 1996.

In March 1997, it was the NGI, which began to protest. The NGI, officially responsible for all topographic mapping in Costa Rica, was not asked to assist in the project. Something had obviously gone sour in the relations between NGI and (what had earlier been referred to in government documents as) 'its committee TERRA'. It wrote a letter demanding that its legal competence be respected. The NGI believed that its jurisdiction had been breached and that its future existence was being threatened. The protest delayed the topographic mapping (again), until May 1997, when the NGI was finally officially invited to TERRA meetings. But also other changes were made to accommodate the NGI.

The administrative delays can be partly interpreted as part of the state bureaucracy's frustration with the lack of investments in public entities, while at the same time foundations, consultants and NGOs were 'booming'. TERRA was seen as just another group of consultants. It was widely believed that after TERRA would be established as a foundation, it would sell the information products (generated with public funds). This assumption was

[49] Government advisor housing sector (M15, 14-03-97) Agricultural Ministry official (M3, 4-06-97)

[50] Interview, November 1997

not surprising, given the earlier experience with the National GIS for Housing and Urban Planning, described before (section 7.3).

> *A representative of the urban sector commented, "...TERRA always presented themselves as a Foundation - read 'a non-public entity' -. It didn't seem rational that a State should transfer its official institutes for basic information to a private institute*[51]*. "The problem now is that all initiatives are moving towards the sale of information and services... That is one of the big reasons for the failure of good initiatives to make an information infrastructure..."*[52].

TERRA took two important measures to counter wider protest. Firstly, it promised to give NGI a copy of the aerial photography and the digital data[53]. This would make it difficult for TERRA to commercially market the maps, and made the NGI central for distribution. Secondly, the former Vice-President was extra-officially appointed as TERRA's new director. It was hoped that his presence could convince the sectoral institutes and state bureaucracy to cooperate.

> *In one meeting the former Vice President remarked: "[T]he idea to become independent ['a foundation'] was too difficult, because the Oil Refinery agreement stated that investments should go to the National Oil Refinery, while the decree of TERRA mentioned TERRA as part of SINADES, and thus the Ministry of Planning....". To break the institutional impasse he proposed to make a network or association of GIS laboratories between several institutes*[54].

After the Vice-President took over and the actual topographic mapping started, some sectoral representatives started showing up again in the TERRA meetings, and TERRA received some information.

Conflict within the executive

To resolve the problems of data exchange the former Vice President proposed to make a network of 7 institutions that would participate, while TERRA and its Geographical Information System would move to one of the universities. Network participants would have to pay for the maintenance of the building, installations, etc.. Participants would benefit from having access to data (a new digital topographic map), services as well as an exchange network for information. Members of the network could also make use of the calculation potential in the National GIS for complicated analysis (Orlich, 1998; Dengo et al., 1999).

[51]Government advisor (M15, 14-03-97); Chapter 4 and 5

[52]Interview with official in Ministry of Planning (M69;7-04-1997), Chapter 4

[53]TERRA meetings (March-June 97)

[54]TERRA meeting notes, 24-04-97

At that moment, however, the Ministry of Environment and Energy tried to intervene. The Ministry was frustrated with the slow progress and frictions around TERRA. The Minister wanted to force the issue and keep the National GIS within his Ministry. The Ministry of Environment and Energy understood that it had already been agreed that TERRA fell under its responsibility. But it now appeared as though TERRA was trying to escape their influence[55]. TERRA responded to this power play by presenting an agreement between the (academic) Technological Institute of Costa Rica and the Ministry of Planning. This document stipulated the transfer of the TERRA's computers to this university centre. At that moment (September 1997), however, the Oil Refinery withdrew the funds for thematic maps and took over the responsibility for TERRA's topographic mapping. The conflict could not have gotten worse and convincing policy makers of the need for their continuation seemed insurmountable.

Existence after a government change?

In the last phase of its existence, we see that TERRA used its GIS as a tool for convincing policy makers of the need for central planning. TERRA designed a set up for the new GIS location, which would immediately convince policy makers of the usefulness of a National GIS for intersectoral planning.

> *The' wish list' for a new location was explained in detail by TERRA's director: "We need space for at least 12 workstations… They should be grouped in three areas, for every theme [environmental, social and economic]"*[56]*. In every area there would be three terminals with in the middle a table where the operators could have their meetings and put their maps and books. There should be room for digitisers, because the analysts were not to do any digitising, and there should be a system manager to change formats, etc. Then, on the other end of the room there should be a conference table. From the table one should have a view over the whole room, including a projection screen over the three work units. One idea would be to put the conference table higher up. Another was to have a room divider to be able to cordon off a separate meeting room. The idea was that during decision-makers' meetings at the conference table, the technicians (on a lower work floor) would interactively engage questions, changes and suggestions for plans in maps projected on the entire wall*[57]*. TERRA's coordinator emphasised the usefulness of this set up:"...I know very well how that works...of course we cannot only show the powerful computers as a result of*

[55]At the TERRA meeting a member summarised this as, "…"Rene" [Minister of MINAE] asks for quick results …and the Direction of Hydro Carbons of the Ministry of the Environment and Energy wants to take over TERRA, with its computers " (TERRA meeting-notes, 22-09-97). This version was confirmed in an interview with former Vice President, Dengo, November 1997.

[56]TERRA meeting notes, 6-10-97

[57]TERRA meeting notes, 6-10-97

what we have done...we have to show beautiful pictures... I already ordered such a big computer projector... which we put in a big meeting room... I want to project our pictures on the entire wall." Laughing, "I know very well how to deal with politicians..."[58].

The presentation of a 'war room' as TERRA's 'ideal working space' underlined their vision of 'remote control' and planning. TERRA especially emphasised the aesthetics and its ability to come up with real time information. There was nothing wrong with the information products and analysis so far, but it was the delivery of information that was the problem. Politicians were perceived uninformed, but with convincing maps they could be led to 'see the light' (glowing from the technocratic solutions).

As a final strategy, TERRA produced three scenarios to use as an example in their war room setting. This was done to appease the IADB as was mentioned at TERRA meetings. "…In the IADB they really pressured us to make three scenario's...to satisfy Perez [high level official from the IADB]..."[59]. If TERRA could convince the IADB, there was hope for the future. The three scenarios were an 'actual land evaluation', and 2 scenarios for Costa Rica (Cotera, et al., 1998). With the little data, TERRA had gathered, it made an 'analysis'[60], based on sweeping assumptions about the future of Costa Rica. The results were presented in three colourful maps. The outcome was conveying the message of an urgent need for environmental projects and investments in eco-tourism. These exactly reflected the priorities of the Figueres government.

In a worse case scenario, little green bits of "correct use" were left in contrast with the rest of the orange and red colours. Colour-wise, a dramatic picture was painted for the future of Costa Rica. "If we threaten Nature [with capital N], Nature will react..." (Cotera et al., 1998:46). "The importance of the scenario is to serve as an element for convincing decision makers to take Ordenamiento Territorial seriously as a priority for the country..." (idem:41). The scenario assumed a doubling of the population. This would result in degradation in all categories of 'the present situation' (in the GIS: a change in colour 'one class down'). The desirable scenario showed a plan with room for forestry, parks and friendly green biological-tourism corridors between parks. A new regional planning division (nicely rounded lines) was made [again!] around central urban locations, that should become service and development centres for every region. Cattle disappeared in the new land use plan, and was replaced by 'permanent crops', agriculture and (lots of) forests. The picture showed that Costa Rica's future would be green: a land for tourism, conservation and forestry, where hydro-electricity could be exported and the cities could have 'clean' computer industries (idem).

[58]TERRA meeting notes, 13-02-97

[59] TERRA meeting notes, 22-11-97

[60] Realising that the GIS analysis was not based on 'scientific fact' the former Vice President later admitted more modestly that "... the information (1:200,000) served to get a general view of the geographical and ecological-environmental condition ...at least until 1992". (Dengo, 1998b:3).

The results were far from what had been expected from TERRA at the outset. In the final stages, TERRA concentrated on making project proposals for the future. As a last resort, the former Vice President tried to legitimise the National GIS, through its move to the Centre for High Technology[61]. At this location, the National Centre for Geo-Information was born. It was created by Presidential decree, but in reality was no more than TERRA's computer storage. The former Vice President presented the Centre as being of strategic importance for the country, with a promising future. If all the scientific information from the different GIS in Costa Rica would be gathered, this National GIS would prove to be "...one of the most powerful tools for the transformation of the country in a real scientific, technological and informatics centre" (Cotera et al., 1998:32). Through this last attempt to make the National GIS 'a neutral and scientific endeavour' he tried in vein to save the project.

In the last months of the Figueres administration, TERRA and the new Centre for Geo-Information existed in name only. Because the 1998-2002 government was not a proponent of intersectoral planning, TERRA disappeared (Dengo, et al., 1999). After some legal studies and investigations around the Refinery project, finally the Hydrocarbons' Directorate in the Ministry of Environment and Energy created its own Centre for Geo-Environmental Information (CENAT), taking over the products from the TERRA project[62].

The TERRA example has demonstrated the Figueres government's creative solutions of governing by decree proved to be counter productive and expensive. It illustrated how visions of organising planning led to different decisions on the development of a national GIS. But, while the National GIS projects were, on paper, aiming at coordination and diminishing duplication, the enormous investments led to more institutional infighting, and confusion over legal competence of data production and distribution.

7.5 Summary and Conclusions

This chapter described various attempts to create a National GIS. We have seen how different planning strategies from the governments in the nineties led to a definition of 'priority' projects in locations. These projects aimed at specific versions of a National GIS for 'ordenamiento territorial'. In both periods, information projects were used as strategic

[61]The choice to locate the GIS in the "Franklin Chang - National Centre for High Technology " gave the National GIS an aura of having the utmost scientific modernity available in Costa Rica. This centre has been managed by the coordinated national universities, for new technology development, together with the private sector. Frankling Chang, a NASA astronaut, is a US citizen and half Costa Rican. The Figueres administration changed the immigration law of Costa Rica especially for him to be able to have two nationalities, and become the icon and ambassador of Costa Rican aspirations for 'high modernity'. As early as 1989, he figured in the first page of the Strategy for Conservation and Sustainable Development report (Quesada, 1990), as an example for all Costa Ricans. After the change in law, the building was named after him.

[62]In 2002, it was serving as another distribution point for the new digital topographic maps, duplicating the tasks of the National Geographical Institute.

tools for institutional reform in land use regulation. While the Calderon government (1990-1994) stimulated the creation of a GIS for steering land use through a functioning land market, the Figueres government (1994-1998) saw a National GIS as a strategic tool for central planning and regulation. We saw that the last attempt for the creation of a National GIS aimed at a combination of a central planning body, supported by the National GIS. For this purpose, the government financed large projects for topographic mapping and the establishment of a computer network in the state bureaucracy. The attempt to enforce its central planning vision through this project failed because of sectoral resistance, tensions between the state bureaucracy and the executive and internal conflicts within the government team. The irony was that GIS location had become the most important stumbling block, when GIS itself is supposedly the 'ideal technology of location'.

In this chapter, we linked the analysis of the implementation of a National GIS for ordenamiento territorial, to the entire field of planning. By looking further than the location of GIS implementation, we were able to show the importance of the projects for how people and institutions were organised, beyond the GIS project itself. In the first period, investments in the Land Registry were not only used as ways to improve the registry of land, but at the same time implied transfer of topographic mapping to this institute. The outcomes of a GIS for urban planning, in the same period, implied a privatisation of information services. Both projects did not reach their goals because of resistance from the National Geographical Institute and the GIS community, which saw themselves becoming harnessed by a commercial information market (instead of getting free public 'official' information). In the second period, proposals were made to transfer the National Geographical Institute to the Ministry of Environment and Energy, while creating an intersectoral planning body 'close' to the President. This central body was to have access to all information. After coming into conflicts with the different sectors and the Environmental Ministry over the final location of the GIS, the project decided to use the investments and technological advances as a power mechanism to 'convince' others of their vision for institutional arrangements. This strategy failed because of resistance from a strong sectoral bureaucracy, disagreements in the Figueres cabinet, and the legal opposition of the National Geographical Institute.

Data quality and technological knowledge proved to be a strategic asset in the negotiations over institutional reform. The chapter has demonstrated that it is difficult to implement ambitious projects for a National GIS, without a clear definition of the institutional context. At the same time, it shows that the choice for a National GIS always implies a political choice for the entire field of land use planning. Even though the projects failed to create a National GIS, the discussions surrounding its implementation forced the different sectors to define their own competence.

8

Discussion and Conclusions

Introduction

Years of experience with GIS implementation for land use planning in larger institutions in developing countries have shown many problems and mixed results. Throughout this thesis I have argued that implementation problems can only be understood by analysing choices of GIS operators on the work floor in relation to the institutional and political context of their land use planning activities. GIS projects are not only about the technological improvements, but also about control over information, information definitions and strategic change in dynamic planning processes. The aim of this thesis has been to come to a better understanding of GIS implementation in larger planning organisations via an analysis of three Ministries in Costa Rica. This chapter will therefore discuss the findings of the case study chapters and draw lessons for GIS implementation in Costa Rica and beyond.

It is appropriate to restate the main research questions:
1) Through which processes is GIS constructed (what is the influence of the main actors, and what is the influence of the structural properties of the context)?
2) What is the influence of GIS-changes (if at all) on Land Use Planning practices?
3) What are the consequences for rethinking GIS implementation?

While in the case study chapters I showed that a contextual approach helps to better understand implementation of GIS in Costa Rica (mostly dealing with question 1) in this last chapter I will compare the case studies to arrive at a synthesis, drawing more general lessons for 'implementation', thus dealing at a more general level with question 1, and subsequently answering questions 2 and 3. First, I recapitulate the main findings of the thesis and its case descriptions in a few summarising paragraphs (8.1). I then provide the case study comparison in 8.2. The idea of 'techno-structuration' as presented in the second chapter, used in the case study chapters, will also help with this case study comparison. First I will discuss GIS implementation processes from a 'limited' project perspective (8.2.1). Then the view is widened to the context of GIS implementation by including institutional embedding, and connected discussions of land use planning, to understand what happened at a more general level. It will become clear that all cases are connected through the discussions about land use planning in general, and that each case forms part of the context of the other (8.2.2). I will end the case study comparison by discussing general notions of the impact of GIS on the practice of land use planning (8.2.3).

The thesis concludes with the question of how to use these findings in new implementation processes (8.3). After making some statements about limitations and possibilities for generalising the Costa Rican case, I will make some concluding comments on the importance of this thesis for discussions on governance and GIS development.

8.1 Summary of the Research Findings

This thesis looked at the implementation of 'institutional GIS' for land use planning in larger state organisations. An institutional GIS is a GIS which influences aspects of the data management and different tasks in an entire organisation or even beyond. The difficulties of implementing such a complex GIS has often led to problems and delays. Studies of implementation have therefore slowly shifted their attention from the technical side of projects towards the 'soft' or 'institutional' aspects of implementation. This thesis has contributed to these new discussions, arguing that 'implementation' is to a large extent 'contextualisation', and the choice for developing GIS in a certain way is a political choice for certain kinds of planning. In the next section, I discuss this in more detail (8.2 and 8.3).

Chapter two of the thesis discussed the issue of 'implementation problems'. A first body of literature suggests that GIS is difficult to implement in the Third World because it is expensive and knowledge-intensive. With declining prices for both soft and hardware, however, implementation problems are nowadays more often related to organisational and institutional aspects. Still, problems of training and infrastructure are important and should be considered. A second body of literature, focusing on approaches from management and organisation science, was useful in pointing out the importance of the relations between (sub) organisations, and the changing responsibilities of information production and use within and between organisations, because of the implementation process. Since the approach is oriented towards prescriptive project implementation, it is weak in explaining why certain problems occur, why some GIS projects were implemented, while others failed, and why power relations between organisations sometimes changed and sometimes did not. In part this can be attributed to the 'ideal-type' descriptions of project implementation inherent in these theories. Implementation is often discussed as an extension of an ideal (and ending[1]) project-cycle, while no attention is paid to the wider context and the 'messiness' of daily practice. Also the literature does not pay attention to the specific content (and its specific

[1] Although a project cycle involves the idea of circular learning and often suggests a never ending circle of activities to improve implementation, in most cases projects are bounded because of donor budgets are given only for a certain period of time. This is why donors always present the projects as investment projects, which will 'stay behind happily forever' after a project ends. A different view of GIS implementation, as reorganising people and organisations, makes us aware of the need for a different structure of 'project finance', more geared towards support of institutional change, which would mean that recurrent costs should be considered in the overall project design.

requirements, problems and politics) of the information system at hand. It is rather different to implement an administrative system on health care statistics than one for studying investment opportunities for agricultural production in certain agro-ecological zones. Actor network theory helped to understand some shortcomings of the former approach by extending the focus of the study of implementation to networks outside the organisations in which GIS was implemented, and by identifying the power of central actors or 'points of passage', such as important donors, academics or NGOs. Through this approach, the politics of projects and information became visible. This analysis had the weakness, however, of too much focus on individual actors and innovators, and of not including the structural and historical aspects of the implementation process. Discussions on information use for land use planning have their historical roots and institutional 'embedding'.

To overcome the weaknesses of the literature, I presented a structuration model for studying implementation, with explicit attention to relations between GIS technology, its department setting, and the wider context. Drawing on Giddens' structuration theory, I pointed to the importance of studying a technology from its practice of design, implementation and use in context. Using Giddens' concepts I pointed to the importance of considering human agents actions as part of a wider structure of ideas, discussions, laws and organisations. Following some examples from literature that use Giddens' theoretical concepts for technology studies (Orlikowsky, 1992; Rammert, 1997), I presented technology implementation as 'techno-structuration'. To understand the institutional dynamics of 'techno-structuration', I used a combination of historical analysis and participant observation of innovation strategies and discussions. It became clear that different institutional arrangements imply certain ways of understanding and organising planning practice and vice versa. This has consequences for the information needs and the way in which GIS will be organised. An anthropological approach gives us tools for studying technology development from a daily practice perspective. The methodological implications of this approach is not simply that a 'project' of GIS implementation should be studied as such, but that the project must be seen in its wider context.

To contextualise GIS implementation, I first described the context of the discussions of land use planning in historical perspective, analysing the institutional properties in which GIS implementation was started, and the general 'GIS landscape' of Costa Rica. The case study chapters subsequently included political developments and changes of the context during implementation, to help understand the dynamics of the institutional landscape.

In the history chapter (Chapter 3), we saw the strong involvement of the state in land use planning. The state of Costa Rica was characterised as centralist and developmentalist, with a large technocratic influence on discussions of land use planning. In the eighties, land use planning changed from finding new areas for colonisation, to changing people's use of land,

to prevent land degradation and stimulate land-use intensification. The country also started experimenting with new environmental policies, generously supported by donors. With the ideas of NGO involvement in park management and debt-for-nature swaps, it became a model for other Latin American countries. GIS implementation started in the nineties. Discussions on land use planning were at that time changing towards environmental regulation instead of direct intervention, while the state bureaucracy was reduced because of a budget deficit and economic crisis. These historical changes had a different impact on the three Ministries (see case studies) and their approach to GIS implementation, because of differences in histories of development and positioning with regard to land use regulation.

To describe the technological context (Chapter 4), I summarised the development of the GIS use in universities, the state and NGOs. Costa Rica was early in developing its GIS capabilities. Many projects started during the nineties, especially in the environmental sector reflecting a donor push and the international climate around the Earth Summit at Rio. Because at the same time the Costa Rican state was being forced to reduce in size, NGO and private foundation involvement in GIS projects was popular amongst donors as well as with Costa Rican technocrats. Because of a neo-liberal climate and the donor push for cost recovery in information production, many NGOs, foundations and university groups were trying to sell their newly acquired expertise and data. Information gathered in one project became a strategic asset to attract new donor money in future projects. The boom in projects did not lead, therefore, to more and accessible information. After 5 years of relatively unsuccessful attempts to create national datasets, the GIS community was frustrated with the difficulties of information access and exchange, and supported the state to take responsibility for producing nation-wide (but open) basic databases. In this context the three case studies should be understood not only as projects for reorganising land-use planning within the receiving institution, but also as ways to overcome data infrastructure problems in a wider application field.

The cases (Chapters 5-7) were described according to a contextual approach as explained in the theory chapter. In each case study chapter, I first explained the general discussions and described the institutional cultures related to the planning topic at hand. This showed that different perspectives and approaches to planning would make different information demands and required different GIS organisation. Implementation problems can be understood better with an understanding of the different planing visions and their respective weight in the state system. Because institutions are not static entities but undergoing constant change, we looked shortly at organisational changes of the GIS locations as influenced by the political developments in the nineties. This helped us to understand the actual forces for change around the organisations implementing the GIS. Each chapter closed with an analysis of the actual GIS projects and showed how substantial discussion about planning, institutional context, and political developments, led to choices (and difficulties) in the

implementation of GIS. The contextual approach not only helped us in understanding GIS implementation problems in each case, but also showed that GIS implementation certainly had an impact on each Ministry.

The first case study of the Ministry of Agriculture (Chapter 5) described the implementation of a GIS for rural land use planning applications within the ministry. In the eighties and nineties the ministry was under attack because of structural adjustment programs and pressures for privatisation of many of its activities. Land-use planning focused especially on land use intensification and assistance to 'modernise' small and medium producers. The history chapter showed that the main actors in the Ministry were a strong regulationist bureaucracy, a new technocratic (more neo-liberal) group linked to the World Bank and the private sector, and a more populist/egalitarian group with links to FAO, farmers' organisations and proponents of 'food security'. During reorganisation, two departments, partisans to the regulationist approach and the populist approach respectively, were forced to merge, causing heated discussion about the way to develop the GIS. The different actors proposed different forms of land use planning and with it different requirements for information use and GIS. First, GIS for extension purposes was pushed by the populists, while the technocrats wanted an open information system for new areas for investment of public and private money. Finally, the regulationists wanted a GIS for application of a top-down land-use capacity system. Only after a general threat of losing all land use regulation responsibilities to the Ministry of Environment and Energy the various actors were forced to cooperate and form a new alliance. The populist and the regulationist elements in the bureaucracy finally proposed a GIS for regulation, but with some local influence in decision making. GIS was strategically used during this reform, and finally it shaped as a new central database supporting regulation but adopting elements of the other strategies. Without this contextual approach, GIS projects would have been perceived as slow and randomly changing in intention, with internal conflicts and without new solutions. The contextual approach showed that GIS was strategically used to keep responsibility to land use regulation and attention for farmer research and extension within the ministry of agriculture. So although GIS was not (yet) directly used as planning instrument it was used to keep power in the sector (thus legitimising planning and GIS).

The second case (Chapter 6) describes the development of a GIS for forest monitoring. While forest monitoring originally was the full responsibility of the state Forest Department, in the nineties two pressure groups helped change the institutional setting. While at first environmental NGOs were given a large role in management of forested areas, in the second half of the 1990s the private forest sector successfully lobbied for deregulation and privatisation of forest regulation. The role of GIS for forest monitoring changed with the shifting importance of different actors. While at first NGOs developed GIS applications for strict enforcement and conservation, later a GIS model was developed supporting private

forestry arrangements. The NGO, FUNDECOR, that was promoting market mechanisms for the forestry sector, developed GIS models for estimating ‘environmental services' of carbon fixation and "carbon bonds". In exchange for sustainable forest use, forest owners would receive a reward for the ‘production of clean air’. The forest would be monitored by semi-private institutes, certified by international agents and the system as a whole was guaranteed by a small but efficient state. GIS was necessary for satellite interpretation for Costa Rica's national forest inventory, for the elaboration of forest management plans, and the control of these plans. Although technically the system of forest monitoring was not perfect, the image of science and standardisation, and the beautiful pictures, were of strategic importance for developing an attractive show-model for the Kyoto Conference in 1997. Through the technostructuration approach we could understand the shifts in choices for the location of GIS for forest monitoring, and the specific aspects of GIS implementation related to these different locations. It also showed how GIS models for forest monitoring contain certain political choices for steering the forestry sector.

The third case was a national GIS for intersectoral planning and geographical information generation (Chapter 7). It was placed on the agenda by the government in 1994. The government tried to institutionalise the GIS within the Ministry of Planning or in the Presidential Office. By implementing the GIS as a separate project the government hoped to prevent bureaucratic limitations. The national GIS would be used for 'ordenamiento territorial', which would produce a zoning plan of the country, applying different laws to land use together with long-term planning studies. The end goal was to become a broker for information, linking the public sector with the private sector, trying to attract national and international funds following long-term scenarios. Different state institutions saw this project as a threat to their independence, and the private sector opposed it because it would mean more state regulation of land use. Although the project in itself did not succeed, it stimulated national digital information production, just as it triggered state institutes to (re)define their responsibilities in land-use planning activities. The technostructuration approach permitted us to importance of institutional reform for GIS implementation. It helped to include different factors to understand failure. These factors were tensions between sectors, conflicts between the executive (government) and the state bureaucracy, and political choices within the government team. It also showed that even though the project itself failed we could understand it as triggering change in institutions beyond the project itself.

8.2 Lessons from the case study comparison

This section (8.2) will specifically deal with the case comparison for a more general understanding of GIS implementation. It will also describe the influence of GIS implementation on land-use planning. First we will compare *what* was changed at a work floor or project level with the GIS in the different ministries (8.2.1). Coming back to the scheme presented in Chapter 2 on techno-structuration (Figure 2.4), this discussion will focus on generalisations concerning the influence of GIS projects and institutions on the construction of GIS (arrows c. and a.) and the changing practices that GIS brought with it (arrow b). What are the commonalties and differences of GIS implementation in the three cases?

In section 8.2.2 it will become clear that although the cases have their own specific properties, all three cases are influenced by the institutional properties of land use planning (arrows c. and f.). Together the cases give insights into the overall discussions on land use planning, which in turn helps us understand the general trends and differences of GIS implementation in the individual cases.

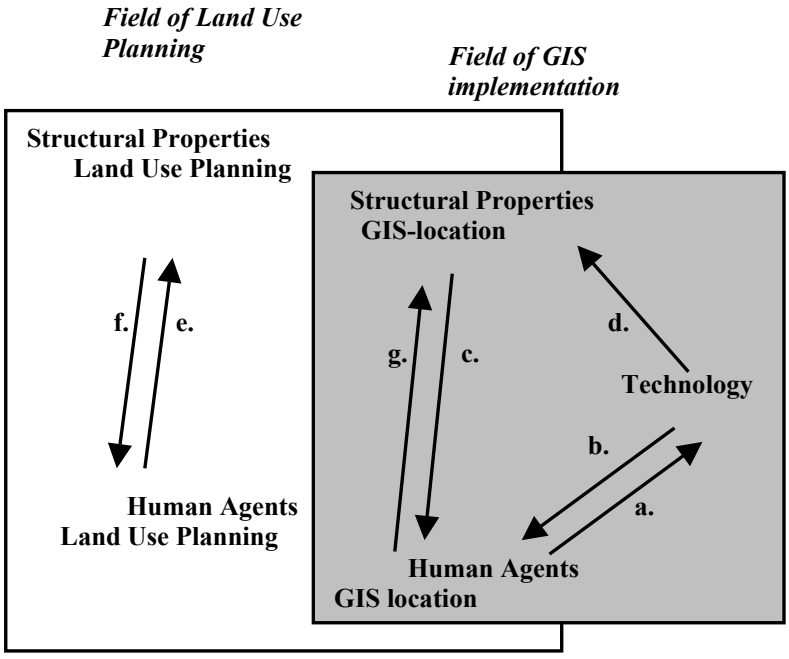


Figure 8.1 Techno-structuration of GIS for Land Use Planning

The section (8.2.3) of the case comparison discusses whether GIS technology, once it is established, has an *impact* on the institutional rules and properties, as new expert systems and ideas materialised in machines and databases. Has GIS impacted on ways in which institutions work? Have practices of information production and map making influenced rules of decision making? Was there a general trend in all cases, or were all cases different?

8.2.1 GIS on the project level

Although this thesis has argued that implementation cannot be understood from project characteristics alone, this section will first compare the implementation of GIS on a project level and draw some conclusions about project implementation and changing applications. What has changed in information use for land use planning with GIS implementation? Referring to the figure above we will look at factors such as the influence of project organisation, donor dependency, management support (arrow c), and gaps between expected project goals (arrow a.) and final outcomes (arrow b). With a comparison of the actual practices introduced with GIS we will be in a position to discuss the common problems of implementation, and understand changes at a general level.

Project formulation and implementation

All project documents on GIS implementation in the three case studies reflected the discussions on sustainable development of the Earth Summit in Rio de Janeiro. The projects wanted to integrate environmental concerns into 'traditional' planning discussions. Also, through the modernisation of the information production and presentation tools, the projects would lead to better and more efficient decisions on land use issues. The language of most GIS projects referred (sometimes explicitly) to 'Agenda 21' of the Rio Summit on Environment and Development, conferring legitimacy to both donors and the receiving organisations. Land-use planning language in general reflected more participatory and market-oriented planning strategies.

As we already saw, in the early nineties all ministries were facing financial reductions because of structural adjustment programs and a growing state deficit. Costa Rica hoped that by presenting itself as a model of sustainable development it would receive more donor money to invest in the modernisation of ministries and in new planning activities. With this strategy it also had to adapt its planning intentions to reflect international discussions, and this brought powerful external actors into local GIS projects. This was reflected in the way projects were formulated. Two cases of GIS implementation were based on World Bank loan proposals, while a third case was based on the experience of a 'pet project' of USAID, the environmental NGO FUNDECOR. Proposals were formulated by officials from the donors and a technocratic group that worked in the state bureaucracy or in NGOs working closely with successive governments.[2] Project aims were perceived differently by different actors in the process. Donor involvement stimulated inclusion of the themes of decentralisation and deregulation as elements, even though this was not necessarily the most important aspect of

[2] Often NGO officials and high level Ministerial positions were interchanged from one government to the next.

the project for the receiving institutions. For the national bureaucracy GIS was often the only way to gain some extra financial support for training, purchase of computers, etc, while government (ministers, presidents and their advisors) saw GIS projects as a way to induce institutional change at a national level.

Projects were not only about computers and software, but all contained a large 'information' component. Although project proposals were not all written at the same moment, they were linked by an overall push from government technocrats (and the wider GIS circles) for nation-wide information. Parts of one project that had difficulties in being approved were taken over by later project proposals, reflecting a general push for information investment. Even though the two World Bank loan proposals were not approved in the National Assembly, governments, bureaucracy and donors kept recycling proposals. The government finally financed a large part of information gathering (through the national oil refinery and a national pre-investment fund) because they saw information as strategic for attracting future projects, and as a way of regulating investments and activities related to natural resources and land use.

Box 8.1 Data Links between Case Studies
First, in 1991 the agricultural sector GIS, with its supporting program worth US$8,500,000, was proposed as part of a World Bank Sector loan to support rural and regional planning (Chapter 5) . When the Assembly finally rejected this World Bank project for the Agricultural Sector in 1994, a new Environmental Sector Loan Proposal took over parts of the proposal from the agricultural sector project (such as nation-wide aerial photography, Chapter 7). This newer project of 1995 (now with an investment in GIS and data collection of US$ 3,600,000) was also supposed to elaborate a forest land-use map for monitoring purposes and was thus linked to the forestry GIS developments. Upon rejection of this Environmental Sector Loan the government implemented a large part of the project through different financial sources (US$3,000,000 from the National Oil Refinery). Although the financial resources were coming from the Environment and Energy Sector, the project was now executed as an intersectoral planning project (Chapter 7). When this project failed to deliver any useful new information, the forestry sector finally elaborated its own maps and GIS facilities (urgently needed for the Kyoto negotiations), investing US$ 500,000 only in the mapping effort (Chapter 6). Although the projects were described in the separate case study chapters we can thus see that they were in no way autonomous, but linked

The relation between government and bureaucracy was key in the GIS projects. While on the one hand, the bureaucracy was interested in these projects for investments in new information, computers and training, the projects, on the other hand, often followed the priority of a government or a minister. Such priority often was different, or even opposed to, that of the existing bureaucracy. The governments, for example perceived efficient information systems as a way of reducing personnel, or intended to change existing institutional responsibilities. This tension between bureaucracy and politicians resurfaces in all three case studies.

In 'traditional' project evaluations often reference is made to 'management support' and financial independence. From the cases it became clear that 'management support' is too general a definition, and to understand implementation, more specific analysis should be made of the different agents involved. We should always ask 'management support' by whom, and to what and whom? Similarly, 'financial support' could lead to smooth project operations (like in the case study on forest monitoring, Chapter 6), while in others it could generate infighting and stagnation (in the case of GIS for intersectoral planning, Chapter 7).

While the GIS for the agricultural sector mainly developed with its own resources and initiative, the other two projects were depending on large sums of project money. Only after developing its GIS capabilities, and the failure of the Environmental Sector project (or later intersectoral planning project), the Agricultural Ministry received state support for soil data collection. The specific combination of financial and 'management support' led to the fact that the agricultural sector GIS developed under the influence of an independent state bureaucracy in a more evolutionary way. The other two projects were run by a 'project management', close to high level government officials. In the other two case studies new 'independent' institutions were developed to steer the generous money flows following the priorities set by the government, relatively independent of the bureaucratic system. The forestry sector GIS grew out of a combination of an NGO (FUNDECOR) pilot project and strong international pressure (USAID) for public/private partnerships in creating environmental services, while the project for the environmental (or intersectoral planning) GIS tried to become an independent 'foundation' or new autonomous state institution, with presidential support, but failed to do so because of bureaucratic resistance.

Because of the different management strategies and financial support systems, the different projects also had different 'GIS-builders', each with their specific qualities and limitations. The agricultural project mainly implemented GIS through the existing personnel from the Ministry of Agriculture. The 'in house' evolutionary way of GIS building resulted in information serving especially traditional hierarchical planning practice. Discussions on GIS implementation took place especially inside the institution, and when a Minister’s advisory team pushed for institutional reform, the GIS project could defend its turf because of its superiority in GIS matters and its data monopoly.

The forestry GIS was developed by an NGO created by USAID and 'transferred' through consultancies to a newly established public/private institution. GIS models, and the 'planning style', were dominated by market strategies. Therefore the project could develop relatively fast, although there was little control over the final product. This meant that the new GIS location was starting with poor or operationally useless databases, and had to do large part of the work again. Still, the final attractive GIS products were successful in convincing national and international actors of the trustworthiness of the new monitoring system.

The intersectoral/environmental planning GIS was built under direct control of high-level government officials. The philosophy was that a core authority of technocrats would build a GIS serving centralised government planning and coordination. But because the source of a large part of the project money was within the state system, it was dependent on the bureaucracy and bureaucratic rules for implementation. This implied for, example, that because of the size of the investments, the project for aerial photography had to be advertised according to official procedures, slowing down progress and flexibility. Although cooperation was limited, the important final results became available years later through a GIS outlet in the Hydrocarbon Department of the Ministry of Environment and Energy.

Table 8.1 GIS Project Characteristics of the Case Studies

Sector	Original Proposal	Main Funds	Year GIS Began	Year Most Funding Received	Management Strategy GIS Implementation
Agriculture	World Bank	Bureaucracy MIDEPLAN	1991	1997	Bureaucratic Evolutionary
Forestry	USAID	Donors(s) USAID/JI	1992	1997	Flexible Adaptive
Regional Planning	World Bank	Government RECOPE & IADB	1995	1996	Centralist Top-down

MIDEPLAN = Ministry of Planning; JI = Joint Implementation; RECOPE = National Oil Refinery

The case studies show that 'much depends' on the specific project and the kind of management and financial support, but also especially on relations between governments' plans, political actors and the bureaucracy, whether and how a project realises certain goals. Obviously there is not 'one' strategy or culture of implementation for the Costa Rican context.[3] Although the main funder has influence on the management strategy of the GIS, we should realise that the financing structure itself is contingent. In retrospect it would seem logical that e.g. the agricultural sector developed in an evolutionary way because of the lack of funds and management support from government circles in an early phase. This outcome, however, was highly dependent on contingent choices and decisions about (failed) project proposals. What would have happened to the implementation process if the World Bank proposal would have been approved? Maybe the large investments in the agricultural and

[3] This idea of 'one culture for GIS implementation' was based on large overall country quantitative comparisons, and is popular in management and organisation studies (e.g. van den Toorn & de Man, 2000). They would classify Costa Rica as a typical Latin American top-down, control-oriented culture, with GIS working for quick and visible results, but with an aversion to evaluating its own functioning and finally positive towards information sharing (idem:101-105). This research shows that very different implementation strategies exist and interact side by side.

forestry sector (Table 8.1) would not have been made if the intersectoral/environmental planning GIS project had had more financial and political support to generate some quick results. On the other hand, the interdependence of the projects meant that power shifts in the direction of one sector would still have been opposed by the other sectors, hampering any potential development - even with substantial political and financial support - of a central intersectoral/environmental planning GIS.

The various cases show that even within a country, a range of management and financial choices influence the outcome of the GIS implementation process. Why choices for a specific GIS models are made can only be understood by examining the historical development of a specific planning discussion, the responsible organisation, and the political context during development. Projects are often strategically used by governments in their attempts to change the organisation of the state planning system. It is therefore not surprising that the relations between government and bureaucracy are key in understanding GIS projects. Before discussing why these choices were made and how actions in the different ministries were interwoven, we will first look at the extent to which projects changed information production itself. Were the ambitious goals of the GIS projects reached? Did the organisational embedding and project strategy affect GIS models? What were the commonalties and differences associated with various GIS products?

GIS: old and new applications

After considering aspects of project formulation and implementation strategies, we will now look at the actual 'construction' of GIS and its results at the project level (arrows a and b in Figure 2.4). All three case studies presented their GIS implementation efforts as part of their strategy to stimulate sustainable development. In the cases, GIS was still in different stages of development and thus hardly operational for defining roads towards sustainability. Even the forestry GIS (which was most advanced towards developing operational products) still had problems with defining GIS products, because of accuracy problems, and problems with implementing experimental results from monitoring and forest management planning systems on a wider scale.

In the introductory chapter, I have already argued that it is too simplistic to say that implementation failed because no radical new products were presented. All projects by the end of the 1990s were able to generate large amounts of nation-wide digital data previously not available. In all ministries GIS became part of a routine for information production and map making. Although it was not clear that GIS caused changes in planning decisions, GIS projects did go together with changes in planning organisation and intention. The commonalties and differences between the case studies reveal how different contexts and

management strategies influenced GIS construction in general. Did the decentralisation and deregulation trends influencing GIS projects affect the information production landscape? Were the different management strategies influencing the GIS construction products?

Looking at the applications of the GIS (Table 8.2), it is interesting to note that although GIS was often presented as revolutionising planning, the main applications were all more or less digital versions of 'old ways of doing things'. Most of the data produced by the projects were digital versions of existing information and maps. Digitisation did not radically change the concepts of data definition and aggregation. The (old) map metaphor still prevailed.[4]

To some extent GIS applications all still accommodated to the change from direct intervention to more coordinating and regulatory tasks. The degree to which GIS was adapted to certain styles of planning - e.g. administrative market planning, incentive-oriented regulation or central state zoning - depended on the specific context. The existing ideas of 'monitoring' or 'regulating land use' by a predetermined land-use capacity were for this purpose linked to new steering mechanisms of tax breaks or a system of payments for 'carbon bonds'. GIS was enabling this change by making it easier to amass and manipulate large amounts of data. This enabled cross-referencing and combination possibilities for map-based data in one central location (but in principle this was not necessarily impossible without a GIS).

Table 8.2 Applications of GIS in the three Cases

Sector	Main Application	Changes	New	What not
Agriculture	Land Use Capability	Zoning & Tax	Analysis (ALES)	Decentralised Information Access and Use. GIS for Extension purposes
Forestry	Land-use Monitoring	Remote Sensing & Subsidy	CO_2 –Calculation	Local Control Forest Management. GIS for Biodiveristy
Regional planning	Intersectoral Overlays	Information in one Location	Digital Topographical Maps	GIS for Analysis. Open Access GIS. Municipal Support. Environmental Regulation

The dominance and adoptions of 'old applications' did not mean that no new applications were proposed or even implemented. Because of its calculation power, GIS did enable calculations that before would have been difficult or impossible to do, like carbon stock-

[4] This implied that it would be difficult to produce radical new potential applications like e.g. geo-statistical analysis, or explicit modeling with many variables. In 1998 Goodchild signals that in the 'developed world' the map metaphor is dominant, but also that this is not surprising given the still 'crude nature' of the technology (Goodchild, 1998).

estimations and land evaluations for extension purposes (ALES). Also, the production of a topographic basemap for Costa Rica (by the regional planning sector) may in the future speed up individual projects and enable the introduction of data standards and data exchange. Only in the forestry sector was the 'new application' of calculating carbon stocks key to the (future) planning application, although the main task of the new GIS department remained the ‘old application’, of monitoring forest management plans.

Part of the promise and goals of GIS projects was related to communication aspects, like attractive presentation, and speed, and effective monitoring capabilities. All projects did (at least partly) reach these goals. In all three cases, the first products were beautiful colourful maps presenting respectively land-use capacity data, forest land-use change and a simple intersectoral land evaluation. The value given to their presentation reveals the logic of many GIS developers and project managers that it is not the quality of data or models that causes the 'non-use' of GIS by decision makers, but their (perceived) ignorance of the existence of these data. In all cases aesthetically presented 'neutral' and 'scientific' data (which itself were unquestioned) were believed to improve awareness of policy makers and open doors to decision making processes and donors.

While the common element of GIS in all the cases was that it supported data concentration and merely aesthetic use of GIS, it has already been mentioned that the different cases used the GIS to support different styles of planning applications. Although it seems that a certain management style would lead directly to the application outcome, the individual case studies showed that the implementation processes were more complicated. Within the cases there was much disagreement over GIS and planning and, as already mentioned above, the case studies were interlinked. Alternative proposals that have not been implemented (last column Table 8.2) often had potentially significant implications for the 'models' in the GIS, its institutional embedding, and data collection strategies. The alternatives involved in the case of the agricultural sector (Box 8.2), for example shows that certain choices and compromises were made during GIS implementation with implications for 'GIS models'.

Box 8.2 Why certain GIS 'models' were marginalised
If we take the case of the agricultural GIS we saw that a merger of two departments in the ministry of agriculture lead to two competing GIS implementation strategies. The 'regulationists' of the 'planning department' defended a top-down land use capacity system, while the 'erosion department' criticised a predetermined land use capacity arguing that choices in land use depend on specific combinations of crops, technology levels and pricing systems. The compromise featured legalising the 'old' land use capacity system, and using 'positive incentives' (tax breaks, instead of punishments) in the case of land-use change or adoption of technological improvements (improving actual land use). This choice implied that the GIS would not be implemented as an extension-support system, or an open access information system for planning new projects and attracting investments.

It is interesting to note that although the planning and regulatory styles on display in the three case studies differed, all three applications seemed to have pushed for central databases to feed decision making at the national level. While not contesting national databases the alternative visions of GIS proposed more local control in decision making (for agricultural extension, local monitoring of forests and biodiversity, and municipal GIS). These approaches were not included as important elements in the implementation processes described in the case studies. Although the language of project documents and donors emphasised a decentralisation in planning (and the use of information systems at a decentralised level), outcomes were the concentration of information and control on a national level. The question remains why these choices were made and why GIS developed the way it did. What has caused this general tendency towards 'old' applications, aesthetics and data concentration?

8.2.2 Generalising GIS implementation from cases: contextualising GIS construction

Although most applications of GIS for information and map production were continuations of 'old' ways of doing things, the cases showed that applications were, to varying degrees, used for new ideas and styles of planning. Still, while in all cases several choices of GIS development could have been made, existing solutions prevailed. For instance, GIS was often presented as a 'decentralising technology', but in all cases the technology was developed to centralise decision making power and control. We will try to evaluate *why* GIS developed the way it did in this section. We will do this by posing the following questions:

1.Is the flexible but centralising nature of GIS an inherent property of GIS technology itself?
2.Was the centralising tendency caused by the character of the Costa Rican state?
3.Or was this result a convergence of planning discussions in times of strict structural adjustment?

To answer these questions we will have to relate the implementation processes to the contextual discussions around the projects. Looking back at Figure 2.4 this means including the wider field of land use planning in the discussion.[5]

1. Technology aspects of centralisation

GIS technology is often presented as a surveillance technology, and resurrecting central planning paradigms (e.g. Pickles, 1995; Lake, 1993). As mentioned in the introduction, I rejected this line of thought because it seems too rigid an application of technological determinism. The fact that in all cases several alternatives and models of GIS

[5] The wider context includes discussions on the nature of the Costa Rican state (Chapter 3), the development of the GIS technology (Chapter 4) and the nature of planning discussions in the 1990s (Chapter 3 and the case studies).

implementation were competing, proves that building centralised systems involved a large degree of choice. Table 8.3 shows the different GIS ideal types as presented by different agents involved in the case studies. Populists and to some degree market proponents proposed schemes implying more decentralised GIS building and use.

Although the technology does not necessary determine the centralisation of the GIS databases, contextual technological factors can still contribute to this development. We therefore have to answer the question whether there are structural technological factors or data limitations in Costa Rica for implementing e.g. a locally-based extension service GIS, or stimulating nation-wide municipal GIS use?

In Chapter 3 and the case studies, we saw that general infrastructural factors (electricity, computers, etc.) were not a problem for GIS implementation. Looking at the GIS installations we could see a definite concentration of GIS projects in the capital city, in central offices of the state, universities and NGOs. Experience in the forestry case study proved, however, that in the rural areas successful GIS applications were feasible. Problems did exist with getting trained personnel in remote areas, and data availability and quality on larger scales (more detailed data) often did not exist or was not present in digital form. The personnel problem was especially visible in regions outside the Central Valley and in municipal governments where there was often too few qualified personnel to start GIS applications. It is, therefore, not surprising that GIS applications were often started in national institutions.

Table 8.3 GIS Models and Intervention Levels by Different Groups Present in the Sectors

	Centralist Technocrats	Regulationist Bureaucrats	Populists	Market proponents
Steering Mechanism	Central Executive	Sectoral Bureaucratic	Local Participatory	Regional Market Based
Agricultural Sector	Potential Land Use for new Investments	**GIS database for Capability System**	Technology for Watershed Management	Potential Land Use for new Crops
Forestry Sector	Biophysical Assessment for Biodiversity & Tourism	Regulation Forestry Capacity	Local Enforcement & Biodiveristy	**GIS for Administration & Monitoring of Carbon Bonds**
Regional Planning	**Intersectoral Zoning and GIS**	Databases for the Sectors	Municipal Planning	Free Information on Natural Resources / Property

The dominant application in **bold**

While at first the explosion of GIS projects caused data secrecy and problems of data exchange standards, frustrations with these problems and the many failures to develop operational results led to a renewed demand from the GIS community and donors to develop nation-wide data. In the light of this new demand, the state could gain influence in producing 'official' information, giving it central responsibility in defining what was key information and how to distribute it.

The perceived need and demand for nation-wide 'official' digital data, together with absence of qualified people and data at the local level, stimulated national level central GIS. The absence of nation-wide data in itself, however, does not prevent the development of locally oriented GIS applications. The 'local level applications', as proposed in the different case studies did not necessarily need nation-wide data, and would only use locally collected (more detailed) information. Although the problems of personnel and data at local level prevented immediate GIS use on this level, these problems were in principle not insurmountable, given the money available for GIS projects. The limitations are caused more by the choice not to transfer the political and economical means to municipal governments (and other local entities) than by the technology itself. In other words it was a political decision about command and control and a rejection of the donor enthusiasm for administrative decentralisation.

2. Centralist Costa Rican State

As we saw in Chapter 3, the state in Costa Rica has been developmentalist, with strong state agencies, and a technocratic focus in land use planning. The main point of many authors is that because the state has a centralist approach to planning, it will resist decentralising its functions or transfer of power to e.g. municipalities discussions (Rivera, 1997; Camacho, 1993). Was this why planning models and databases in GIS were so centralised?

Although the centralising tendency was present in the Costa Rican state, it certainly was subject to dynamic and constant changes. How the different ministries reacted differed case-by-case, but in the 1990s the centralising tendency of the state institutes and ministries certainly was weakened. State institutes (reluctantly) decentralised part of their activity, but the bureaucracy certainly slowed down this process by arguing that many responsibilities could not be decentralised, because of the level of technical expertise required (Rivera, 1997). The state was also not monolithic. Different influences were present in all ministries, causing a different degree of openness to deregulation and decentralisation of tasks.

The reaction of different ministries to the pressure to decentralise was different in all cases. The Ministry of Agriculture resisted pressures with formal reactions, slowing down the process, while the Ministry of Environment and Energy embraced the idea. The

Ministry of Planning, finally, tried to use the reforms to gain intersectoral control. The influence of pressure groups and political wrangling explains the different strategies of the ministries towards reforming planning and steering mechanisms, varying from direct state influence in zoning (Ministry of Planning) to use of market mechanisms in the forestry case. In all cases although part of the planning responsibilities were deregulated (to municipalities, forest owners or farmers in watersheds), coordination and regulation tasks were kept centralised with help of central databases and GIS. GIS was one of the tasks that the state institutes argued for as too difficult to decentralise because of the lack of local expertise. In this sense the tendency of the Costa Rican state to keep power centrally concentrated plays a role in explaining the tendency to create central databases. Why was a central database important even for the 'neo-liberal' planning philosophy? The real importance of the centrality of databases for the manoeuvring around and redefinition of state institute roles can only be appreciated from considering the role GIS and information plays in the redefinition of state planning and planning discussions.

Box 8.3 Influence of Different Planning visions in the three Ministries in the 1990s

Table 8.4 Influence of Different 'actors' in the Ministries

	MAG	*MINAE*	*MIDEPLAN*
Centralists	-	+	++
Regulationists	++	-	+
Populists	+	+	+/-
Market Proponents	+/-	++	-

MAG = Ministry of Agriculture; MINAE = Ministry of Environment and Energy; MIDEPLAN = Ministry of Planning

The different ministries of the case studies all reacted differently to the dynamics of the structural adjustment programs, because of their histories and the influence of different pressures groups in these ministries. The Ministry of Agriculture was probably the most conservative and 'traditional' planning-oriented Ministry, defending its 'old ways' of functioning. Still, a populists stream had influence on land use planning through a FAO project calling for more direct support for small farmers, participatory watershed management schemes and technology development. The Ministry of Environment and Energy started on the basis of 'creative finance' by e.g., debt for nature swaps, and was mostly inclined to new experiments with participatory and market-oriented regulation of land use, and proved open to decentralisation of its steering mechanisms, working closely with donors and NGOs. In the forestry case we saw that a weak 'regulationist' state institute lost its influence over forest regulation to a public/private state fund for forest subsidies. Environmentalists within the ministry also had considerable influence over regulation of forest use. The Planning Ministry, working directly under the president, was more oriented towards centralist and technocratic decision making, although within the ministry there existed a stream of proponents of municipal decentralised planning. While at first the Ministry was the motor of regionalisation, during the eighties the ministry was weakened, closing its regional offices altogether in the early 1990s, thereby losing its direct influence over land-use planning. Still, in the late 1990s the ministry tried to redefine its tasks as a coordinator of intersectoral planning, as reflected in the case study of Chapter7.

3. Planning Discussions and GIS Implementation

In the 1990s the planning discussions changed. Experience with years of failing top-down land use planning projects caused a growing protest from neo-liberals, populist farmers and environmentalists, all calling for more direct influence by 'civil society' (citizen groups and private companies) in decisions over land use and the environment. The demand for less rigid state intervention, together with a general global neo-liberal wind, made 'planning' a dirty word, not to be used in official documents.

In land-use projects and programs, the state redefined its central tasks to be those of coordination and regulation of activities, 'centralising information strategically while decentralising and deregulating actual practices' (MIRENEM et al., 1995a:48&131). GIS was presented as strategic technology for monitoring and administering land-use change, giving the state enormous potential for control. GIS and central information were strategic for part of the state to survive in times of large reductions of the state system, but the central databases were also necessary for this new role in planning. With the new task for the state as coordinator, regulator and broker for private activity, the need for information grew exponentially. In addition to the negotiation of the extent of deregulation and decentralisation of actual application of land use regulation and enforcement, the state was put back at centre stage for planning through information and GIS. Even 'market adherents' called for a small but strong and *informed* state, to guarantee a functioning market. Lean states were to be smart. Smart meant control over abundant information.

Although there were different planning philosophies, the idea of central coordination was present to some degree in all proposals and directions for GIS implementation (Table 8.3). While technocrats wanted to steer planning from a position close to the president or minister, their intervention proposals were diverse and oriented to decentralised levels. Bureaucrats in all case studies proposed certain forms of decentralisation, but following the rules of a game set in law and controlled by the central state. Market proponents needed central systems for standardising and guaranteeing the value of products for sale, whether carbon bonds or land titles. The production and free distribution of information was also considered a state task (although not necessarily centrally organised) in that it would correct market failures (e.g. unequal knowledge opportunities concerning agricultural systems and prices), and that it would give equal opportunities to all producers and potential investors. Finally populists, proposing GIS implementation for mainly local applications, were not against some sort of central system to monitor regional differences, to be able, to redistribute wealth from richer to poorer areas of the country. In short, everybody was in favour of some form of a central information system.

The detail information shows, however, that the content of the models for planning was different in each of the three case studies. The differences lay especially in the steering mechanisms, also implying different information needs and databases. Why certain choices were made did not only depend on institutional negotiations within the state system, but also on the general planning discussions itself. With the redefinition of state tasks, the issue of responsibilities came back onto the agenda.

The planning discussion was focused not only on the degree of intervention or regulation by the state but also on its sectoral responsibilities. Firstly, with the separation of the Forestry Department from the Ministry of Agriculture, a new division of responsibilities had to be made. The tension between the rural sector and the forestry sector was resolved with the legal stipulation of the policy of 'no land-use change' for forest areas. The forestry sector accepted this because of the adoption of a forestry law stipulating that forest land owners were to face fewer bureaucratic obstacles for exploitation of the forests, and would receive rewards for their 'environmental service'. The new reward system 'needed' a central GIS for regulating the subsidies and for creating international legitimacy. The rural sector in turn developed a central system for land-use capability because it had to defend its regulatory role against attacks arising from the creation of an institute for intersectoral/regional planning and from the transfer of responsibilities to municipalities. The central GIS was important in defining new areas for interesting crops and in attracting capital from foreign donors and investors. The intersectoral/regional planning GIS finally lost the battle against bureaucratic resistance and resistance from the private sector for a national regulatory body for land use. The idea was to create a state institute with functions rooted in the environmental responsibilities of the state. It would regulate all land-use issues centrally (and close to the president). The 'environment' was defined as an intersectoral issue. Instead of the creation of a presidential regional zoning institute, however, with transfer of GIS capacity to the Ministry of Energy and Environment, the responsibilities were redefined as environmental and natural resource management, making the environment only of sectoral interest.

Not only was nation-wide information a key for administrative purposes, but 'the official' status of information also gave the responsible institute legitimacy for its tasks. The redefinition of planning in times of structural adjustment, and the redefinition of the state as coordinator and regulator, were therefore very important in explaining the centralised implementation of the GIS projects. Institutional factors had a clear influence on GIS implementation.

8.2.3 Influence of GIS on Institutional Rules and Regulations

Although we saw above that the implementation of GIS did not radically change information production and map making, we still can ask whether GIS technology, once it is established, has an influence on institutional rules and properties of planning. Even if the GIS technology itself at first sight does not radically change practices of information production, we saw that its specific construction could go together with new ideas of planning. Did the technology have an impact on materialising these new ideas in computers and databases? How (if at all) have GIS projects impacted on the ways institutions work. Does GIS technology influence the rules of decision making? (Figure 2.4: which arrows had most impact on structural properties of land-use planning; arrow d or arrows g and e?)

Looking at the main applications of GIS, not a lot has changed. GIS was used for entering a soil map in the computer and elaborating a capacity map with it, monitoring land use with remote sensing was not in any revolutionary way different from the former aerial photography (and early satellite applications by foreign universities), nor was the elaboration of topographical maps in digital form yet generating new uses. Still, GIS changed some aspects of information production that potentially might have had an impact on planning structures. Let us subsequently evaluate the impact of the three aspects of changes of the technology we identified in section 8.2.1:

- definitions of categories and conceptual content,
- central storage and concentration of information
- presentational aspects.

Data concepts and content

Given a tendency of using GIS for doing 'old' things digitally, it is difficult to find direct and clear examples of a radical influence of the GIS itself on planning. The combination and cross-referencing of 'old data' and concepts that are now put into a computer could, however, have an impact, and we will come back to this below, discussing the consequences of data concentration. But let us first look more closely at the changes in data, and concepts that were introduced with the GIS.

The agricultural GIS worked mainly with digital soil maps and the old land-use capability system in its planning philosophy. Although the agricultural GIS planned to work with a more detailed soil map during GIS implementation, this did not change the concept of planning itself. The proposals for the use of the soil map followed the same ideas of applying the land-use capability system or finding agro-ecological areas for new crops. Although new ideas of land evaluation were developed combining economic and ecological factors, and analysing actual farmers' strategies, these were not put into practice on a large scale due to institutional factors described above. The GIS was mainly used to promote existing concepts.

The claims of more detail in the soil map, and the introduction of modern technology, were more used to legitimise the promise that the Planning Department would in the future work more efficiently than that it changed actual planning practice.

The regional/intersectoral planning GIS used existing official data of environmental variables for its 'traditional' zoning purposes. This emphasis on environmental data reflected a particular stream in the Figueres government to which the presidential committee belonged. After the project's failure and transfer of the GIS to the Ministry of Energy and Environment emphasis changed to data production for hydro-carbon exploitation. These changes and choices reflected the power struggles and planning visions of the actors involved, rather than aspect of GIS itself. The GIS in the project was often presented as a powerful tool for new applications and for 'interactive planning' by decision makers, once it would be fully operational, but the actual results were, at most, nice colourful maps of old and existing data.

The main GIS applications in the forestry case were those of monitoring forest land use and administering forest management maps. These applications did not change planning ideas either. Only one conceptual aspect introduced changes in the forestry case. With the introduction of satellite images as an official monitoring tool for the forestry law, the definition of 'forests' was limited to forest areas that were visible on current satellite images[6]. With the use of satellites for monitoring, the emphasis also changed to keeping 'forests' (managed or not) in place, and not on its biodiversity conservation. The reason for this is that only clearcuts could be perceived well on these images, while it is not possible to monitor 'selective felling' with these tools (Holmgren & Thuresson, 1998). Although the exact definitions of 'forest' were directly related to the technological possibilities and limitations of GIS and remote sensing, the idea of limiting state responsibilities to monitoring global land-use change and emphasis on stimulating forest use (instead of conservation or management of secondary growth and plantations) was more related to ongoing pressures and discussions in the field of land-use planning itself. GIS was used as a tool for showing the feasibility and credibility of the ideas, and legitimising these ideas, even though the actual monitoring stipulations of the forestry law (which included selective felling regulations) could not be realised with GIS and remote sensing alone because of lack of detail and precision.

While the GIS projects often promised new and modern uses of data, applications were not directly changing planning practices. The GIS was used, however, to legitimise certain ideas as 'scientific', and GIS was presented as potentially overcoming old problems of the 'non-

[6] E.g. in the forestry law of 1995 a forest area was defined as areas *bigger than 2 hectares*, with a forest canopy cover of at least 80%. Areas smaller could not be perceived on satellite images.

use' of data by the possibility of more attractive presentation, in greater detail, and in a more timely manner.

Data concentration and combination

While we have seen how contextual factors led to implementation of centralised databases, we now want to ask if this data concentration in itself had an impact on planning practices? With the introduction of computers and GIS, the three ministries had the possibility easily to cross-reference data, like linking taxes with the land use capacity system, or forest subsidies with forests management plans. GIS also led to a concentration of 'official' data in one location and, as we saw in the case studies, gave power to its owners to distribute it freely or not. This last aspect gave the institutions coordinating roles in (future) planning processes. The central database function thus had an influence in giving the ministries new roles for coordination and control in a reformed state system and a changing planning landscape.

Although the cases show that GIS as a coordinating tool had an impact on how planning responsibilities were divided, it is not the 'nature' of GIS that determined the location for data management in (say) the Forestry Department or the National Forestry Fund. The location in the three cases was clearly determined by political choice and the relative power of the bureaucracy. Although in every GIS project the promise was made that improved data management, efficiency and better analysis would lead to better coordination of activities, it appears that it was more 'talking' about these future applications that legitimised the changes pushed forward by different actors, than the actual improvements in practice.

Map Presentation and Aesthetics

GIS changed the way maps are presented. Presentational aspects were important in conveying a sense that future GIS applications were 'inevitable' and 'logical'. The image of modernity of computer presentations (with beamers or enormous wall covering screens) were important for impressing policy makers, donors and politicians. In all projects, even though the results produced with the new databases were very meagre, computer tools helped produce attractive presentations. In this way GIS helped to convince policy makers to do what "the technocrats had calculated in a neutral way" (TERRA meeting notes).

In the agricultural project and the intersectoral/regional planning project, the aesthetic aspects of GIS were used to present old data in colourful ways, in order to convince the president, high level decision makers and donors of the necessity of project continuation. Aesthetic functions were used for strategic reasons, while actual practical uses of GIS maps were presented and assumed to be logical future outcomes of this technology. In the forestry GIS, the presentation of beautiful maps was used to show actual changes in practices. The maps of forest land use were presented as proof of the functionality of the Costa Rican forest

monitoring system. The state used this presentation on a national level to herald the 'carbon bonds' as the 'new coffee of the century', a claim - perhaps to be welcomed with scepticism - that had a major impact in creating support for the Costa Rican market model for forestry regulation. The promise of large money inflows guaranteed by the 'science' of the new monitoring system silenced most protest. Beyond the national level, the maps were presented as proof that Costa Rican models worked. Even without a thorough analysis of all the difficulties mentioned in Chapter 6, the result of the negotiation, and subsequent donor support, shows that the GIS monitoring system was taken as valid by international negotiators. Also literature on this topic shows the confidence of many authors writing about 'the carbon business' in the Costa Rican case. Still, the GIS was used more to convince negotiators, than as a practical tool to guarantee a proper monitoring process (remember that only clearcuts could be seen on satellite pictures). Foresters and environmentalists agreed that monitoring of selective felling could only be done 'on the ground' by certifiers (as proposed by proponents of the market system) or state foresters (as proposed by bureaucrats and environmentalists).

Although the presentational aspects of GIS were not used in planning practice, they were used to convince policy makers and donors to continue along a chosen road (be it a market regulation of forestry, or an 'old fashioned' capacity method for rural planning). This showed that 'talking with convincing beautiful maps in hand' has thus far been the most important change to be credited to the introduction of GIS in the Costa Rican case.

Talking about GIS

In all three aspects of information production and map making (Data concepts, concentration and presentation) the GIS projects did not directly change practices of planning but rather legitimised these practices. Although potentially some changes were feasible e.g. building GIS as a decentralised extension support system, or using GIS as decentralised forest monitoring tool (Table 8.3), it was political choices with respect to institutional change that determined the way in which GIS was built, and used, and hence its (limited) direct impact on planning.

In all projects, GIS was presented as revolutionary new technology, with high potential for future use. Referring to old planning discussions, GIS project managers presented GIS as the ideal tool for finally bringing information in 'real time' and in an 'attractive way' to policy makers. It was more important to show policy makers *that* a GIS was introduced, than *what* this would potentially mean for information production and map making. Although not actually functioning (yet), the GIS projects legitimised the future central coordination role of the state in finding new areas for commercial crops, mining, or other interesting investments. This would help the government to stimulate new foreign revenue-generating activities in

times of urgent need to service debt. It also was to attract foreign investors, showing possibilities for investments, while at the same time GIS would help promote and demonstrate the efficiency, modernity and trustworthiness of the Costa Rican state. The information system was to give the state the task to function as a broker between the private sector and public interest.

The presentation of impressive maps, with a promise of becoming a central node in information production and coordination, was often enough to be taken seriously by policy makers and donors. GIS projects were strategic tools for choices in institutional change and agenda setting. In all three case studies, GIS projects were presented as neutral technology and as information production projects. Still, the GIS departments and the actors of the projects were all also explicitly involved in law making about institutional change for land-use planning and regulation. Although we saw that technology could not (yet) live up to the requirements of a monitoring system concerning of land-use capacity or forest use, it legitimised changes in regulation. What was presented as 'technology transfer' proved to be political projects concerning institutional change. This means that behind the proposals of GIS implementation we have to look at the way in which GIS stimulates continuation of institutional functions, changes or reform. The final outcome of implementation of GIS in Costa Rica did not depend on the inherent aspects of the technology but more on the built-in choices and the institutional changes surfacing while 'talking about GIS' (arrow g and e in Figure 2.4). The ideological aspects of computer science, aesthetics and demonstrable exactness were enough to point back to the value inherent in the owner. Talking with GIS was talking 'neutrally' about 'obvious' political choices concerning institutional reorganisation. In this respect, a GIS is not telling the truth about the environment but a tool for talking politics.

8.3 Implementing GIS or Re-Organising Planning Practice?

Returning to the definition in the first chapter where we considered 'GIS as a tool', we now realise that the use of the tool can only be understood from its built-in practices and the manner in which its use is organised. In constructing GIS choices are made about databases and information needs. These choices determine possible uses and accessibility of information. Certain forms of planning and scales are built-in, enabling and limiting certain planning practices. The case studies showed that GIS implementation processes were not so much about technological aspects of chips, computers or software, but more about organising people, information and institutions; it was not the hard technology but the way information, data bases and output were designed and structured which was important in the institutional GIS projects.

In the three Costa Rican case studies the 'institutional side' of GIS, - historical factors, pressure groups and political developments – had to be taken into consideration to explain choices and outcomes. GIS stimulated the concentration and integration of planning variables, although the overall applications were more continuations of old concepts and existing practices. It did not revolutionise planning and analysis, as was heralded by many GIS donors, GIS-businesses and projects. GIS implementation centralised control and decision-making power to national organisations. The concentration of information systems was caused by the combination of pressure for institutional reform and pressure for state reduction in a strongly centralised state. The state redefined the state planning task as one of coordination and regulation for which information was a central resource. It depended on the specific context of the case, however, whether GIS enhanced market, state regulation or direct state steering mechanisms.

To what extent can we extend these findings from the three Costa Rican case studies to other developing countries? Is it possible to draw lessons for GIS implementation beyond 'it depends'? Often even people involved in GIS implementation in Costa Rica sighed that it was difficult to say something general because of the volatile political situation. Managers and their policies would be changed with every shift in government, or corruption blocked every structured management attempt.

This thesis argues that it is exactly because of the approach and perception of 'implementation' that these frustrations are not anticipated and perceived from the start. We will conclude that an approach to implementation that follows 'project cycles' will not be able to deal with the problems and frustrations described above. If we start from GIS as technology *with* its organisational context, implementation would look different. We will therefore redefine 'GIS-implementation' starting from a 'process planning' approach, and give some recommendations for future projects.

8.3.1 Generalising lessons from Costa Rica

How typical are the problems and outcomes of GIS implementation for Third World countries, in Latin America and beyond? Are the reasons for concentration and centralisation of information only typical for Costa Rica?

GIS improved certain practices of information production and map making through its calculation speed, overlay and presentational aspects. Still, very few new concepts were introduced with the introduction of GIS, and GIS did not cause a radical change in planning

practice[7]. The 'conservatism' of GIS for planning can partly be explained by the relative 'crudeness' of the technology (Goodchild, 1998), but also as a reflection of the planning practice in general. Planning and regulation are slow processes, and often there is no guarantee that plans will be implemented at all (Rakodi, 2002). Often actual planning is informal, instead of a rational decision process, and sometimes the right information for decisions is non-existent, or as Christiansen (1995) signals, there might be too much information. If planning is itself relatively conservative, and not totally dependent on 'timely information of high quality', we cannot expect a great demand on GIS use and new applications from practice. GIS will therefore probably not (or maybe not yet) revolutionise planning practice in any other country of the world[8].

If not directly changing actual planning practices, is GIS always as strategic for legitimating changes in institutional reform processes as in Costa Rica? To answer this question we have to look at the existence of causal factors behind specific developments in Costa Rica. The presence of a strong central state was one aspect explaining the tendency to favour centralised databases. In many discussions on Latin America, the centrality of the state and the importance of centralised political power is seen as an inherent characteristic of the state (Harris, 1983; Mouzelis, 1994; Rivera, 1995). If GIS and central databases are constructed in state institutions that have already a tendency to centralise - even if the rhetoric around GIS is the opposite - we can also expect that GIS databases, access and control will assume a centralised character. Latin America is not the only example, though. In literature about GIS in developing countries South East Asia is often mentioned as a region where centralised, monopoly-controlled geographical databases prevail, sometimes connected to the need of authoritarian and military regimes (Fox, 1991; Walsham & Sahay, 1997). Regardless of the context and the country, the fact that the possibility of centralisation through the technology exists will attract powerful players to this aspect. Therefore the centralising aspects of GIS can be extrapolated to much of Latin America and probably beyond. To which extent this centrality is a problem will be discussed in a concluding comment, where we will discuss the new 'GIS fad' around governability and democratisation.

Just as centralised state control is part of the ‘Latin logic’, so is change in planning discussions penetrating many third world countries as a result of the standard prescriptions of deregulation and decentralisation by the international financial institutions (e.g. World Bank, 1997; Slater, 1990, Rondinelli, 1990). In most cases, states look to redefine their planning tasks, and the literature around 'public-private partnerships' shows that ideas of redefining the

[7] Some suggestions were: on-screen planning, fuzzy logic and changing concepts in geography, calculation of intersectoral development plans with many future scenarios, scientific analysis of land, land use and planning, decentralised access to all databases of the country.

[8] It is therefor not surprising that recent literature signals that GIS use around the world is often based in old practices (van der Toorn & de Man, 2000).

state as a coordinator and regulator of land use is widespread. We can therefore expect that GIS will appear as a potentially strategic tool for this coordination task in struggles for institutional change around the world.

For which regulatory regime (market planning, regulatory or direct state intervention) GIS will be used, and by whom, will depend on the context. As demonstrated in the cases, even in one country and with one technological development level, it depended on the specific situation of the organisation, actors and their embedding in the national political landscape what form GIS would take. Although very general as a statement this conclusion has far-reaching implications for 'implementation' of GIS projects.

8.3.2 Redefining GIS implementation?

Should any 'implementation' project now contain a total study of the context? Let me start by saying that this thesis did not aim at a new and better 'recipe' for implementing GIS. The case-study approach was especially important for understanding GIS implementation processes and answering why so many projects do not attain the goals of project implementation plans (if they exist in the first place). With the answers of this thesis we can try to discuss implementation and, as I will argue now, we should start thinking differently about 'implementation' of large institutional GIS in complex organisations.

This thesis shows that GIS should be understood from the practice of its planning applications, and that therefore implementation is about organising and re-organising information, people and institutions. This makes it necessary to rethink old ideas about project cycles, and stop seeing GIS as a technological add-on. Instead we have to think of GIS as part of the re-organisation of work processes and institutions.

The dominant literature on GIS implementation based on 'organisation and management theories' shows a growing consciousness of the social aspects of GIS implementation. Its advice would be to adapt the classic project cycles of 'programming, identification, design, support, implementation, evaluation' to more 'participatory goal setting', and to pay more attention to feasibility, flexible planning, incremental experimentation, and even 'business area analysis to identify and prioritise business processes to be re-engineered or automated, or identify the areas of high political or economical impact to be addressed first' (Ferrari & Onsrud, 1995:9.2.1). The inclusion of more actors from within the organisation in which the GIS is implemented and an open discussion about goals in GIS projects could lead to more successful implementation. Still, the approach focuses on GIS as a neutral technology and very much follows 'project thinking'. This project thinking means that almost always donors, and decision makers on the receiving end are mostly concerned with smooth project plans, operation and measurable results, with little attention to the daily messiness of planning

practice and change (by computers or otherwise) (e.g. Byron, 1997). Who is involved in decision making, who is affected, and why certain projects get funded and others not is outside the area of analysis of these approaches. The case studies in this thesis showed that GIS projects were part of government officials' and donors' plans to change institutions. Both were pushing for implementation of GIS with their own characteristics, and with the GIS specific choices were put on the agenda, while others were purposefully kept off. This shows that technology is not a neutral tool and its construction certainly involves choice. In the dominant literature there is some attention to conflict; but only as conflict between actors in the organisation in which GIS is built, because of the changing work practices and resistance against changing responsibilities. With attention to open discussions and 'positive organisational behaviour' the otherwise neutral technology will be implemented successfully. The cases showed, however, that sometimes there are no clear solutions to conflicts, and that, moreover, certain styles of GIS have consequences for planning practices and empower certain groups (land users, environmentalists, forest owners, investors) beyond the organisational setting of the GIS implementation projects.

The actor network school gives special attention to networks of actors and power. In the three case studies we saw the importance of donors and links with government, the president, or powerful lobbies in the National Assembly. Implementation, in this view, becomes more a process of knowing the right people. This school of thought would advise that implementers should be networkers and initiative-rich innovators. They do not expect a lot from project management (Chan & Williamson, 1999). Many persons in the Costa Rican GIS world subscribe to this view when evaluating projects and the daily politics of working in a Ministry. Political support is often not stable, and to get something done, one has to be creative and convince the right people. Networks of power are important but they cannot explain why these innovative people and powerful networks do exist, and why they are promoting certain options of GIS development and not others (like e.g. supporting market regulation in the forestry sector while promoting top-down regulation in the Ministry of Agriculture and why the president and his technocratic government team was not able to introduce a central GIS for land use planning).

So while the network theorist would say implementation is difficult to steer and depends on external power networks and work-floor creativity, the organisation and management approach still sees room for some steering, in flexible projects where it is important to involve and convince the whole organisation to cooperate. Both approaches focus on the technology plus only part of the context: the actor network approach focuses on the technology as part of the power network of actors, undervaluing history and institutional trajectories in the generation of ideas about GIS and planning, while the organisation and management approach assumed technology to be neutral, and focuses only on the organisation of GIS. Both miss the picture of structuration and construction of the content of

the GIS, in our case the land-use planning process and its institutional organisation. If GIS is more about organising people and organisations, then 'implementation' also should be perceived differently. It is more a matter of servicing an organisation that ‘thinks’ than designing an information processing system.

Taking a techno-structuration approach, the design of databases and digital maps becomes a discussion about institutions and how to of plan, organise and reorganise approaches to planning (or 'planning styles'; Thompson, 1998) at different scales. Following Biggs & Smith's advice on project implementation in general, and specifically following the lessons of this thesis, implementation would improve if one looks at it more as 'people activities' bounded by 'institutional cultures'. This would include the creative actors involved in GIS implementation, but also the structural preconditions for their activities and discussions. As I described above, a combination of historical and political analysis can give insights into the main discussions on planning approaches. The dynamics for institutional change will be determined by the recent political developments of institutional change within the state system. As this thesis showed, the state is not an unchanging and monolithic entity, but it is likely that discussion on a nation-wide level will be found in the different locations for GIS implementation, and that dominant ideas will be subject to change due to political developments. In implementing GIS, one should be conscious of the historical background and approaches to planning of the institution within which the GIS is implemented. Implementing a GIS with a populist orientation to planning is difficult to realise from within a hierarchical state bureaucracy, as is proven in the case study of the Ministry of Agriculture. This realisation can help prevent failures and identify weaknesses of certain institutional arrangements for specific approaches to planning (e.g. "lofty ideals and a participation approach in a hierarchical or ... [corrupt] local setting is doomed to fail") (Biggs & Smith, 2002). Implementation therefore involves a complex steering of ongoing processes, and concern for political feasibility and choice, instead of transferring technology and technifying databases.

Can a GIS contribute to the creation of better institutional arrangements? To understand what kinds of institutions exist I pointed to the importance of historical analysis, while change should be understood as a product of the influence of politics (e.g., changing governments, power groups & donor policies) on the institutional setting. As we have seen in the case studies, GIS projects often are part of the agenda for institutional change of governments, and tend to be seen as neutral and attractive projects. Understanding the context empowers those who are involved in GIS projects to identify choices and to assess the 'fitness' of certain ways of organising GIS within institutions. We now have seen that certainly many types of organisations are possible. To which extent politicians, managers, planners and implementers have power to change or steer projects will depend on the balance of power of actors and institutions at that moment. This thesis has shown that there is a degree of flexibility in

implementing GIS (there were different types of GIS implemented) although projects are limited by their institutional embedding (e.g., there was no populist GIS in the top-down Ministry of Agriculture). Also, as 'talking about GIS' is often used strategically in institutional reform processes, GIS implementers and planners can use an understanding of context to make choices explicit, and to analyse the consequences of these choices for state reform projects.

The current discussions of many GIS projects present GIS as an ideal tool to stimulate good governance through decentralisation and democratisation. While we have seen that possibly GIS can contribute to these goals, we now understand that it will first depend on the institutional setting if this will actually happen. It often appears as though the current discussion echoes former errors of seeing GIS as the panacea for everything.

8.3.3 Governance and the importance of GIS

At the GISDECO-Conference of 2002 on GIS and Governance, at ITC, Enschede, many presentations were made by academics and professionals dealing with GIS projects in developing countries. The theme for the conference was optimistic, 'after the problems and dangers, and the potential applications of GIS as themes from the GISDECO conferences of the nineties, now the organisers wanted to show the important contributions GIS could have in daily practice' (GISDECO, 2000). Discussions on GIS and governance often were related to issues of improving information quality and access, decentralisation and municipalisation of government tasks, land tax issues and forms of interactive participatory planning (e.g., GISDECO, 2002; Olowu, 2002; Rakodi, 2002; Kam, 2002). Most papers, however, hinted at the actual failure of implementation of GIS, and indicated frustrations with the final use of the “beautiful product”. Databases were made for municipal governments but there was no 'institutional embedding' for its use, or perhaps 'ignorant' or 'corrupt' state bureaucrats did not see the potential of these GIS efforts.

The focus on technology and implementation as 'transfer' processes seems to lead to the same problems as in the past. Just as the idea of the 1990s that GIS would automatically lead to 'sustainable development', now with 'governance', expectations are high that GIS will lead to better and transparent decision making. The lessons of ten years of experimenting with GIS projects for sustainable development did not lead to the adoption of a more interdisciplinary approach to GIS building. There is no 'obvious' reason to believe that GIS information will be used more easily for ‘democratisation and decentralisation’ than it was for 'sustainable development’.

Can GIS still be important for good governance? GIS use depends on its institutional embedding, type of steering mechanisms (market arrangements, state planning or regulated

use) and scales of interventions. Many of these issues are locally/country dependent and are to a large extent political issues. If we want to stimulate democratisation with a GIS for governance, it is necessary to look for the appropriate institutional framework. Also we have to realise that sometimes information is not available, and when this is the case, we may find that planning is informal and hardly based on 'official' information use. In such cases GIS may not be useful at all.

Also many discussions on GIS and governance assume that decentralisation of information systems will automatically lead to better decision making. In this thesis it became clear that to a certain extent many different pressure groups, including populists, agree that certain forms of centralisation are necessary for the coordination and protection of the public interest. It is more the style of planning that is chosen that determines the political choices to be made concerning information, and not the scale. A local-level GIS that supports a corrupt local elite or excludes poor farmers because of poor conditions for market participation will definitely not lead to more democratisation and governance. By contrast a central GIS that puts equity on the agenda, or that makes government functioning more transparent could lead to the goals envisioned by 'good governance' (see also e.g. Thompson, 1998; Slater, 1989 & 1990).

As good governance is often linked to a right to transparent information, GIS can play a role in stimulating institutional change that enhances democratic decision making. In this thesis we saw that GIS is often part of an institutional reform process, and although not yet directly influencing institutional rules and practices, it does legitimate choices for strategic future developments about who will be responsible for information coordination (e.g., sectoral/intersectoral), and which steering mechanisms will be used in planning. GIS implementers have to consider therefore contextual developments, to be able to make clear choices on how to stimulate governance with information models and to understand the implications this has for steering mechanisms of planning.

As GIS building often takes place during institutional reform, politicians from their side also should consider debates about implementing GIS. They should not only consider the promises and limitations of technological developments, such as data quality, scale and presentation (the 'limited' version of GIS implementation), but also the more general consequences of future GIS use for steering mechanisms and coordination responsibilities (a more 'contextual' version of GIS implementation). Implementing GIS for governance thereby becomes more an interdisciplinary activity in which GIS is one of the dependent variables for which the outcome has to be understood just as much from a sociological and political perspective as from its technology management side.

Annexes

Annex 1

Data sources of the GIS inventory 1996-1998

GIS Locations of Costa Rica	**Interview**	**Documents**
Acuaductos y Alcantarillados		X
Catastro Nacional	X	X
Centro Agronómico Tropical de Investigación y Enseñanza	X	X
Centro Cientifico Tropical	X	X
Chiquita		
Consevación Internacional	X	
Comision Nacional de Emergencias	X	X
Corporación Bananera Nacional	X	
Comision Consultiva de Ordenamiento Terriotiral (TERRA)	X	X
Desarrollo Rural Integral Peninsular	X	X
Escuela de Agricultura de la Region Tropico Humedo		
Fundación Internacional para la Restoración, Educación y Manejo Ambiental (FIREMA)	X	X
Fundación Neotropico	X	
Fundación para el Desarrollo de la Cordillera Central	X	X
GEODATA	X	
GEODIGITAL		
ICE Departamento del Ambiente y Energia Alterna	X	X
Instituto de Desarrollo Aagraria	X	
Instituto Geographico Nacional	X	X
Instituto Interamericano de Cooperacion en Agricultura	X	X
Instituto Meteorologico Nacional	X	X
Instituto Nacional de Biodiversidad	X	X
Instituto Technológico de Costa Rica	X	X
Ministerio de Agricultura Projecto FAO	X	X
Ministerio de Agricultura Departamento de Suelos y Evualuación de Tierras	X	X
Ministerio de Recursos Naturales Departamento de Planificación	X	
Ministerio del Ambiente y Energía, Oficina de Areas de Conservación	X	X
Oficina Regional del Area de Conservación de la Cordillera Central	X	X
Oficina Regional del Area de Conservación de Guanacaste	X	
Ministerio del Ambiente y Energía Departamento de Geología		
Ministerio de Obras Publicas e Transportes		
Municipalidad de Heredia		
Municipalidad de Alajuela		
Municipalidad de San José		
Municipalidad de Curridabat		X
NUMAR		
Projecto Río San Juan (Organización de Estados Americanos)	X	X
Organización para Estudios Tropicales	X	
Projecto del Area de Conservación de Tortuguero	X	X
Projecto Fronteras Agricolas		X
Servicio Nacional de Riego y Avenamiento	X	X
Sistema de Información sobre Vivienda y Asentamientos Humanos	X	X
Universidad de Costa Rica Departamento Geologia		
Universidad de Costa Rica Departamento de Geografia	X	
Univeridad de Costa Rica Departamento Centro de Investigaciones en Geofisica	X	
Univeridad de Costa Rica Departamento Programa de Investigacion de Desarrollo Urbano	X	X
Univeridad de Costa Rica Centro de Investigacion y Enseñanza de Desarrollo Sostenible	X	X
Union Internacional para la Conservacion de la Naturaleza	X	X
Universidad Nacional Geografia	X	X
Universidad Nacional Observatorio Vulcanológico y Sismológico de Costa Rica	X	
UNA-Telesig	X	X
UNA- Laboratorio de Oceanografía y Manejo Costero	X	X
UNA-Biologia		
UNA-Topografia	X	X

Annex 2

Documented Interviews, Conversations, and Notes on Gatherings and Meetings

Documented Interviews and Conversations[1]

Categories	#
Historical	11
Current Planning	60
GIS	88
Donors	9

Categories	#
Ministry	50
Autonomous	14
Government	35
NGOs	24
Private Sector	15

Documented Meetings, Gatherings and Events concerning Land-Use Planning and GIS

Categories	#
TERRA meetings	17
IICA meetings	34
Farmers meetings	5
Other Events	6

[1] I included the interview reports (17) of the questionaire on GIS by research assistance (Diaz, 1997a)

Annex 3

The Cattle Data Discussion

Many authors claimed that there was a crisis in the cattle sector, given low productivity and decrease in international prices since the late eighties. There was some suggestion that the total area of grasslands have declined, although the figures were inconclusive (Table A4.1). The number of registered cattle has decreased from between 2.1-2.4 million in 1988, to 1.6 million in 1994, reaching a low of 1.3 million in 2000 (CORFOGA, 2001; Berti-Lungo, 1999). Still total production of meat has not declined as dramatically as the drop in total animals would suggest (Fig A4.1). Imports of cattle and meat since the early nineties could explain only a slight part of the sustained meat production (SEPSA, 1999).

Table A4.1 Estimates of pasturelands over time according to different sources.

Source: Author:	Various Ibrahim et al., 2000	Census Sanchez, 2000	IGN-UNA Fallas & Savitsky, 1996	*IMN* *IMN, 1996*	*Census* *CORFOGA, 2001*	*SIDES* *MIDEPLAN, 1996*
1979				*917,786*		
1984	*2,229,100*	*1,650,000*	*2,058,698*			*1,558,000*
1988	*2,426,500*				*2,420,118*	*2,229,000*
1992			*2,416,100*	*1,659,727*		
1994	*2,000,000*					*2,850,000*
1996						
2000					*1,349,628*	

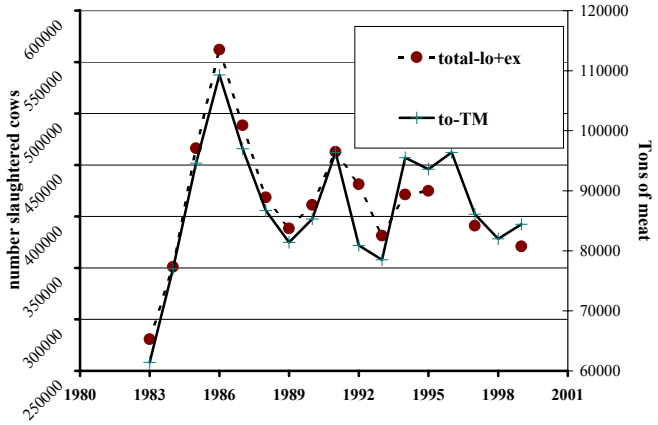


Figure A3-1 Number of Cattle Slaughtered and Total Meat Production (SEPSA, 1999 &1993)

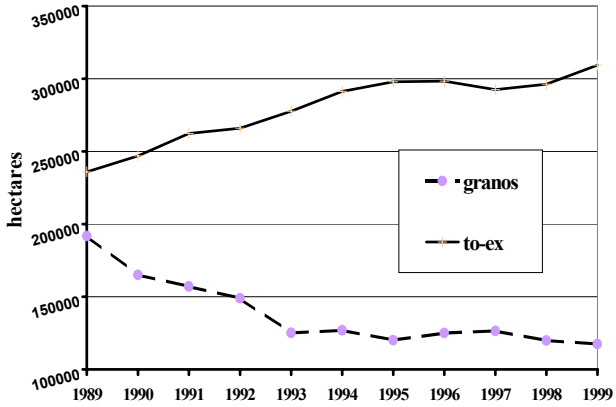


Figure A4.2 Land Use Change of Basic Grains and Export Crops (from: SEPSA, 2000)

The most recent study on land cover change suggested an increase of at least 130.000 ha in secondary forests somewhere between 1986 and 1997, indicating that pasture area has been transformed into forest (FONAFIFO, 1998). Other reports indicated that pasture area has been fragmented and was shrinking in extension especially in areas the Northern Atlantic Region and in the Northern Region, because of the growth of around 30.000 ha. of banana and orange plantations in areas with large cattle farms (Brooijmans, 1996pc; Solano et al., 2000). Analysing total agricultural areas, however, raises questions. Areas covered with basic grains has diminished by around 70.000 ha. In the same period the total area under export crops increased by the same amount (Figure A4.2) while total area under agriculture stayed more or less the same between 1989 and 1999. These figures do not confirm the argument that many cattle production areas have been transformed into areas under export crops. Pointing to reductions of cattle, others authors estimated a decrease of 400.000 to 600.000 hectares of abandoned pasturelands. Probably the figures were based on the number of cattle (reduction from 2.1 to 1.6 million) and a density of the Costa Rican average of 0.8 heads/ha., amounting to around 600.000 ha (Vasquez, 1992b; Monge, 1994). These assumptions would lead to an overestimation of the total area of abandoned pasturelands since land first taken out of production would be land with lower stocking densities. This example shows that reliable information was unavailable, and that different sources interpreted data differently. These different interpretations were often used strategically supporting particular changes in policies, for or against the cattle sector.

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Dutch Summary / Samenvatting

Verbeelding van Planningsvergezichten: onderzoek naar de invoering van GIS voor landgebruiksplanning en regelgeving bij Costa Ricaanse overheidsinstanties.

Geografische Informatie Systemen (GIS) zijn sinds begin jaren 90 gepresenteerd als een belangrijk instrument voor landgebruiksplanning en regelgeving. Er werd verwacht dat GIS zou leiden tot een sneller en beter gebruik van informatie in beleid. Veel donoren hebben overheden in de derde wereld gestimuleerd deze technologie te gebruiken om efficiëntie en transparantie te vergroten. Uiteindelijk bleken dit soort projecten vaak problematisch, en door de vele mislukkingen bij de invoering ervan werd GIS vaak bestempeld als de '*white elephant'* van de jaren negentig. Het doel van deze studie is om de moeilijkheden rond de invoering van GIS beter te begrijpen en om aanbevelingen te doen voor toekomstige projecten. De studie levert ook een bijdrage aan de theoretische discussie rond de institutionele aspecten van GIS.

Dit proefschrift past de ideeën van Giddens toe op technologiediscussies. Hiervoor wordt het concept van 'techno-structuratie' gebruikt. Dit betekent dat bij de bestudering van technologie rekening moet worden gehouden met technologische en structurele beperkingen, zonder de creativiteit van individuen uit het oog te verliezen. Een beter begrip van de invoering en het gebruik van GIS vereist daarom studie van de institutionele omgeving, alsmede begrip van de dynamiek van de praktische toepassing van de GIS in kwestie. Dit proefschrift kiest daarom voor een contextuele benadering met drie casestudies waarin de invoering van GIS voor landgebruiksplanning bij de Costa Ricaanse overheid vanuit de dagelijkse praktijk wordt bestudeerd. Hoewel specifieke contextuele factoren niet zomaar te generaliseren zijn, helpt het concept van 'techno-structuratie' bij het trekken van een aantal algemene lessen voor de invoering van GIS elders.

De Costa Ricaanse staat heeft door de jaren heen een sterk gecentraliseerd systeem voor landgebruiksplanningssysteem ontwikkeld. Ondanks de druk op de staatsbureaucratie tijdens twee decennia van structurele aanpassingsprogramma's (1980-2000) om te dereguleren en te bezuinigen is de staat een belangrijke speler gebleven. GIS werd bij de staatshervorming gepresenteerd als een oplossing voor veel problemen, en de staat experimenteerde al vroeg met invoering van de technologie. Staatsinstituten wezen

hierbij op hun eigen rol in de productie van officiële informatie voor planning en regelgeving. Hoewel aanvankelijk de samenwerking tussen GIS gebruikers groot was, leidde de grote hoeveelheid donorgeld in de context van bezuinigingen en reorganisaties tot moeilijkheden. De definitie van - en toegang tot informatie werd van strategisch belang voor de coördinatie van taken, legitimatie van activiteiten en voor de verkoop van informatie. Al deze factoren vormen de achtergrond voor de invoering van GIS in de drie Ministeries die in dit proefschrift worden behandeld.

De eerste casestudie (het Ministerie van Landbouw) laat een belangenstrijd zien tussen aanhangers van drie verschillende benaderingen van planning. Deze benaderingen hadden implicaties voor de manier waarop gedacht werd over het ministerieel GIS. De eerste benadering hield in dat GIS gebruikt zou worden voor voorlichting en technologie ontwikkeling voor kleinere boerenbedrijven. Het tweede idee was dat GIS gebruikt zou worden voor deregulering en decentrale planning, terwijl de laatste benadering GIS zag als een technologie voor nationale zonering en regelgeving. De mislukking van de eerste twee benaderingen kan alleen begrepen worden doordat de sterke staatsbureaucratie veranderingen wist tegen te houden. Het succes van de laatste benadering voor de invoering van GIS, en de uiteindelijke institutionalisering ervan wordt beschreven vanuit de sterke sectorale belangen die deregulatie wilden voorkomen, en invloed wilden behouden in rurale planning ten tijde van groeiende invloed van andere ministeries in rurale gebieden.

De tweede casestudie beschrijft de invoering van GIS voor bosbouw regulatie. De opeenvolgende regeringen verschoven hun benadering ten aanzien van het bosbouwbeleid. Verschillende invalshoeken werden uitgewerkt in drie locaties elk met een eigen visie op het gebruik van GIS. Naast een traditioneel top-down bosbouw beleid door de staatsbosbouwdienst werd ook geexperimenteerd met participatieve methoden door milieu-NGOs. Later koos de regering voor een benadering die marktsturing voor de bosbouw sector voorstond. Bij elke benaderingswijze pasten verschillende GIS methoden. Het eerste GIS was meer aangepast aan hiërarchische regelgeving, het tweede meer in lijn met participatieve planning en natuurbeschermingsdoelen, terwijl het laatste GIS diende voor het creëren van standaard modellen voor de berekening en controle van CO-2 opname als een milieu ‘verdienste’, die beloond moest worden. De uiteindelijke keuze voor het laatste sturingsmodel en de invoering van GIS in een publiek-private instelling kan alleen begrepen worden vanuit een bestudering van de historische context. De internationale druk om dit voorbeeldmodel te laten slagen was van grote invloed op de keuze en uitvoering van GIS in Costa Rica. GIS speelde een belangrijke rol in het creëren van een ‘internationale standaard’ en een beeld van wetenschappelijkheid, alsmede voor het maken van aantrekkelijke presentaties, die dienden als overtuigend voorbeeld op de Kyoto Conferentie van 1997. Doordat GIS vooral vanuit internationale motieven was aangestuurd, was er minder aandacht voor de kwaliteit van de modellen en de praktische uitvoering op lokaal niveau.

De derde en laatste casestudie onderzoekt de invoering van een nationale GIS voor intersectorale planning. Dit idee werd door de regering in 1994 op de agenda gezet met als doel een centrale GIS in het Ministerie van Planning te creeeren. De regering hoopte bureaucratische problemen te omzeilen door de invoering van GIS als een zelfstandig regeringsproject op te starten. Dit nationaal GIS zou gebruikt worden voor ruimtelijke ordening, met een nationale zonering voor het hele land, volgens de vele verschillende wetten en regels voor landgebruik. Ook zou het Nationaal GIS centrum kunnen dienen als een informatiemakelaar die de publieke en de privé sector zou kunnen koppelen voor het aantrekken van nationale en internationale investeringen. De keuze van de locatie, en de verbinding van GIS en controle over de regulering van land gebruik, bleken echter politiek gevoelige zaken. De verschillende staatssectoren, spanningen tussen de bureaucratie en de regering en verschillende visies binnen de regering zelf leidden uiteindelijk tot de mislukking van de ambitieuze plannen. Hoewel het project zelf mislukte, stimuleerde het de productie van digitale kaarten en veroorzaakte het een discussie binnen het staatssysteem over de verdeling van verantwoordelijkheden en de uitvoering van landgebruiksplanning.

Op theoretisch niveau wijzen de bevindingen van dit proefschrift op het belang van het meenemen van de gebruikscontext voor het begrip van de institutionalisering van GIS. GIS is meer dan alleen technologie en de organisatie van haar onderdelen. De praktische implicaties zijn dat elk project dat zich bezig houdt met de invoering van GIS, zich meer bewust moet worden van de sociale, organisatorische en politieke keuzes die achter de technische voorschriften schuilgaan. De Costa Ricaanse casestudies maken duidelijk dat er grote druk bestond om het staatsbestel te verkleinen. De terugtrekking van de staat uit directe interventie betekende dat informatie steeds belangrijker werd voor staatsdiensten. Informatie garandeerde immers het behoud van macht en legitimiteit in de nieuwe rol als coördinator en regelgever van private activiteiten. Een vergelijking van de casestudies leert ten eerste dat verschillende contexten en actoren tot verschillende vormen van institutionalisering van GIS kunnen leiden. Ten tweede bleek dat de invoering van GIS net zozeer een zaak is van planningspolitiek als een technische of organisatorische kwestie. Tot slot moeten actoren die betrokken zijn bij staatshervorming en beleid meer aandacht besteden aan GIS, vanwege het in dit onderzoek aangetoonde stategische belang ervan voor discussies rond ‘*governance*’ en discussies over coördinatie en sturingsmechanismen

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Hugo Jeroen de Vos (born in Hengelo (O), the Netherlands, 1965) completed his secondary education in Enschede (Ichthus College). He began his MSc in Soil Science and Land Evaluation in 1984. As part of his MSc he did thesis research on soil erosion in Spain and on soil variability and nitrate leaching at Tauw Infraconsult in Deventer. In 1989 he worked for the Dutch Royal Tropical Institute (KIT), in Mali. He graduated in 1991 with two honours theses in rural sociology (erosion and social differentiation in Mali) and political science (national park policy in Nicaragua).

After his studies he edited and co-authored articles on environmental degradation and society and organised several seminars and workshops. Since 1994 he has been a research fellow of the department of Technology and Agrarian Development at Wageningen University and Research Centre and received a research grant in 1995 from the Netherlands Foundation for the Advancement of Tropical Research (WOTRO). From 1996-1998 he was a visiting researcher at the Interamerican Institute for Cooperation in Agriculture (IICA), San José, Costa Rica.

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